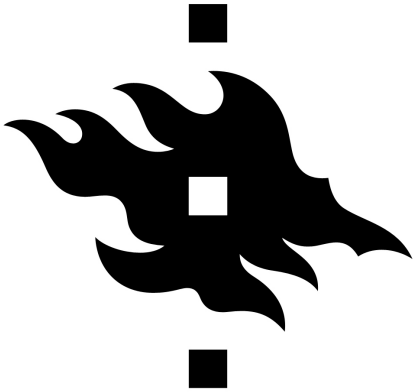

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Perceptions of the Profitability of Wooden Multistory Construction and Ways of Enhancing It

Faculty of Agriculture and Forestry
Department of Forest Sciences
Forest Economics and Marketing
Master's Thesis
Katri Konttinen
November 2019

HELSINGIN YLIOPISTO — HELSINGFORS UNIVERSITET — UNIVERSITY OF HELSINKI

Tiedekunta/Osasto — Fakultet/Sektion — Faculty	Laitos — Institution — Department
Faculty of Agriculture and Forestry	Department of Forest Sciences

Tekijä — Författare — Author
Katri Susanna Konttinen

Työn nimi — Arbetets titel — Title
Perceptions of the Profitability of Wooden Multistory Construction and Ways of Enhancing It

Oppiaine —Läroämne — Subject
Forest Economics and Marketing

Työn laji — Arbetets art — Level	Aika — Datum — Month and year	Sivumäärä — Sidoantal — Number of pages
Master's Thesis	November 2019	58 + Appendices

Tiivistelmä — Referat — Abstract

The construction industry together with the use of buildings generates a significant amount of the European Union's greenhouse gas emissions and uses vast amounts of energy, materials and water. Increasing wooden multistory construction (WMC) could be a way to enhance the sustainability of the construction sector, since studies have shown that the lifecycle carbon dioxide emissions and energy-use are smaller in wood-framed buildings than in corresponding buildings built with concrete. Several national and multinational authorities have set targets for increasing the share of wood in construction to decrease the environmental impact of the construction sector, but the share of WMC has increased rather slowly despite the political support. According to previous research, the reasons for the slow growth of the industry include for example path dependencies of the construction sector (i.e. that past events affect future decisions and events), attitudes and lack of knowledge. This thesis aims at increasing the knowledge of the profitability of WMC by finding out the perceptions of WMC experts on the current cost level in WMC, discovering factors that affect the profitability and market share of WMC and finding ways to enhance the profitability of WMC.

This study is qualitative and was conducted using semi-structured theme interviews. Six professionals of the WMC industry were selected using purposive sampling and interviewed in 2017. The main criterion in the selection process was that the interviewees are in a decision-making, senior level position in their company and have prior experience about WMC.

The results of this study indicate that WMC is currently more expensive than building with concrete. According to the results, the main causes for the higher costs are lack of knowledge, low number of actors, costs caused by planning and difficulties in tendering. However, WMC industry professionals believe that the profitability of WMC will increase in the future and that the market share of WMC will grow. Based on the results, the best ways to increase the profitability of WMC are learning from repeated projects, product development, utilizing industrial construction, cooperation with other companies and open dialogue with public administration. Furthermore, the professionals emphasized that wood should become a genuinely competitive construction material and that wooden construction's competitive advantage should not be dependent on support from politicians, municipalities or city planning.

Avainsanat — Nyckelord — Keywords
Wooden Multistory Construction, perceptions, profitability, construction costs, future trends

Säilytyspaikka — Förvaringsställe — Where deposited
E-thesis [ethesis.helsinki.fi/en]

Muita tietoja — Övriga uppgifter — Further information

HELSINGIN YLIOPISTO — HELSINGFORS UNIVERSITET — UNIVERSITY OF HELSINKI

Tiedekunta/Osasto — Fakultet/Sektion — Faculty	Laitos — Institution — Department
Maatalous-metsätieteellinen tiedekunta	Metsätieteiden osasto

Tekijä — Författare — Author
Katri Susanna Konttinen

Työn nimi — Arbetets titel — Title
Käsityksiä puukerrostalorakentamisen kannattavuudesta ja sen parantamisesta

Oppiaine —Läroämne — Subject
Metsäekonomia ja markkinointi

Työn laji — Arbetets art — Level	Aika — Datum — Month and year	Sivumäärä — Sidoantal — Number of pages
Maisterintutkielma	Marraskuu 2019	58 + liitteet

Tiivistelmä — Referat — Abstract

Rakennusteollisuus ja rakennusten käyttö aiheuttavat merkittävän osuuden Euroopan Unionin kasvihuonekaasupäästöistä sekä energian, materiaalien ja veden kulutuksesta. Rakennussektorin kestävyyttä voitaisiin parantaa puukerrostalorakentamista lisäämällä, sillä tutkimuksissa on todettu puukerrostalojen elinkaaren aikaisten hiilidioksidipäästöjen ja energiankulutuksen olevan pienempiä kuin vastaavien betonikerrostalojen päästöjen ja energiankulutuksen. Rakennussektorin ympäristövaikutuksia pienentääkseen useat kansalliset ja kansainväliset toimijat ovat asettaneet tavoitteita puun käytön lisäämiseksi rakentamisessa, mutta poliittisesta tuesta huolimatta puukerrostalorakentamisen markkinaosuus on kasvanut hitaasti. Toimialan hidas kasvu johtuu aiempien tutkimusten mukaan muun muassa rakennusteollisuuden polkuriippuvuudesta eli edellisten tapahtumien vaikutuksesta tuleviin valintoihin ja tapahtumiin, asenteista sekä tiedon puutteesta. Tämän tutkimuksen tavoitteena on lisätä tietoa puukerrostalorakentamisen kannattavuudesta selvittämällä puukerrostalorakentamisen ammattilaisten käsityksiä puukerrostalorakentamisen tämänhetkisestä kustannustasosta, tutkimalla puukerrostalorakentamisen kannattavuuteen ja markkinaosuuteen vaikuttavia tekijöitä sekä etsimällä keinoja puukerrostalorakentamisen kannattavuuden parantamiseksi.

Tämä tutkimus on kvalitatiivinen ja toteutettiin puolistrukturoiduilla teemahaastatteluilla. Tutkimukseen valittiin harkintaan perustuvaa otantamenetelmää käyttämällä kuusi haastateltavaa, joita haastateltiin vuonna 2017. Haastateltavien valinnassa käytetyt kriteerit olivat, että haastateltavat ovat työpaikallaan päättävässä asemassa ja että heillä on aiempaa kokemusta puukerrostalorakentamisesta.

Tutkimuksen tulokset osoittavat, että puukerrostalorakentaminen on tällä hetkellä kalliimpaa kuin betonikerrostalorakentaminen. Tärkeimpiä syitä puukerrostalorakentamisen korkeammille kustannuksille ovat tutkimuksen tulosten mukaan tiedon puute, toimijoiden vähyys, suunnittelusta aiheutuvat kustannukset ja ongelmat projektien kilpailutuksessa. Haastatellut kuitenkin uskovat, että puukerrostalorakentamisen kannattavuus paranee tulevaisuudessa ja että sen markkinaosuus kasvaa. Tutkimuksen mukaan parhaita keinoja kannattavuuden parantamiseksi ovat toistuvien projektien kautta tapahtuva oppiminen, tuotekehitys, teollisen rakentamisen hyödyntäminen, yhteistyö muiden toimijoiden kanssa ja avoin dialogi päättäjien kanssa. Haastatellut asiantuntijat painottivat erityisesti sitä, että puun kilpailuedun ei tulisi perustua poliitikkojen, kuntien tai kaupunkisuunnittelun tukeen vaan puun tulisi olla aidosti kilpailukykyinen muiden rakennusmateriaalien kanssa.

Avainsanat — Nyckelord — Keywords
puukerrostalorakentaminen, käsitykset, kannattavuus, rakennuskustannukset, tulevaisuuden trendit

Säilytyspaikka — Förvaringsställe — Where deposited
E-thesis [ethesis.helsinki.fi/en]

Muita tietoja — Övriga uppgifter — Further information

Acknowledgements

I would like to thank Prof. Lauri Valsta and Dr. Jenni Laininen for supervising my work and giving me valuable comments, suggestions and support during the process. Furthermore, I am most grateful for the encouragement and advice I have received from my friends and family during my studies and the process of writing this thesis.

Additionally, I would like to thank Dasos Capital Oy for providing funding for this thesis.

Table of Contents

1 Introduction

1.1 Background

Climate change is one of the most important global challenges and topics of public discussion in the 21st century. Hindering global warming requires action from all countries and all industries, and the construction industry makes no exception. According to the European Commission (2011), construction industry together with the use of buildings generates roughly 35% of the European Union's (EU's) greenhouse gas (GHG) emissions. Furthermore, construction and use of buildings account for 42% of the EU's final energy consumption, more than 50% of extracted materials and 30% of water use (European Commission 2011). Therefore, improving the energy and resource efficiency of the construction industry and lowering its GHG emissions would notably improve the EU's stand in the fight against climate change.

One way of enhancing the sustainability of the construction industry is choosing wood as construction material. Studies have shown that wood-framed construction requires less energy than concrete-framed construction and that lifecycle carbon dioxide emissions are smaller in wood-framed than in concrete-framed buildings (e.g. Gustavsson et al. 2006). Wood can also be re-used better than concrete after the demolition of the building, assuming that wooden components can be easily sorted from other material. If a wooden product cannot be used again after one service unit, the material can be re-used as material for new products (e.g. fibre board or pulp), burned for energy or landfilled as the least favorable option (Jungmeier 2001). This cascade model is in accordance with the EU waste framework directive's hierarchy (European Parliament 2008), which aims at increasing the re-use of products and materials and reducing the amount of waste on landfills.

These properties of wooden construction have raised interest of researchers and politicians seeking for cost-effective ways of reducing GHG emissions around the world. Legislation regarding wooden construction has been loosened and modified (see for example The National Building Code 2017), research groups focusing on wooden construction have been established (e.g. Taste of Wooden living – KäPy in the University of Helsinki) and programs promoting the use of wood in construction, such as the Wood Building Programme coordinated by the Finnish Ministry of the

Environment, have been created. Furthermore, both national and multi-national actors have set concrete targets for increasing the share of wooden construction. For example, The European Forest Sector Technology Platform (2012) targets tripling the share of wood-based construction in Europe from 2010 to 2030 and the Finnish government has declared that the use wood in construction should double between 2019 and 2023 (Finnish Government 2019).

The largest possibilities in increasing the share of wooden construction lie in the construction of apartment blocks, since the market for apartment blocks is growing and the share of wooden construction in the market is small (e.g. Forecon 2017). Urbanization has increased the number of people living in apartment blocks as employment and housing have concentrated to large cities, and the demand for apartment blocks is forecasted to continue growing (e.g. Vainio 2016). In 2017, the number of Finnish household-dwelling units living in apartment blocks grew 1.9% from the previous year and totalled 46% of all units (Official Statistic of Finland 2017a, hereafter OSF). To add, 69% of all completed dwellings in Finland in 2017 were in apartment blocks (OSF 2017b). The share of wooden framed construction from all apartment block housing starts in Finland was only 4.3% in 2017 (Forecon 2017), which would suggest considerable opportunities to substitute other construction materials, e.g. concrete, with wood.

The need for more sustainable urban housing has been recognized also in research literature. Toivonen and Viitanen (2015) defined urbanization and environmental pressure as two of the nine categories of forces of change affecting the future commercial real estate market in the Helsinki Metropolitan Area in Finland and stated that actors that are well-informed and can adapt to the occurring changes can gain competitive advantage in the market. Likewise, Toppinen et al. (2018b) claimed that growing consumer demand for green building and sustainable living will make sustainability a megatrend in housing. Also the experts of the wooden construction industry share the same view and believe that the societal need for sustainability will lead to changes in regulation and increase the importance of sustainable development in the construction sector in the coming years (Toppinen et al. 2018b).

Sustainability of the material is not the only reason to increase the use of wood in urban construction, since wood can be a particularly good material in urban environments,

complementary building and extensions due to its lightness and shorter construction time. Wooden elements can be prefabricated indoors, which considerably shortens the on-site construction time (e.g. Riala and Ilola 2014) and thus disturbs the surrounding environment less in terms of traffic, noise and dust detriment. Shorter construction time also reduces the risk of weather damage, given that the elements are erected under suitable weather conditions. Furthermore, lightness of wood allows using wooden construction in problematic sites with many layers of infrastructure underground (Hurmekoski et al. 2018).

Wooden multistory construction, later WMC, is defined as the construction of over two stories high residential buildings with wooden frames. In Finland, WMC was long restricted by regulation, but experiments with building higher with wood began in the early 1990's as increased environmental awareness encouraged finding new uses for wood and considering ecological values also in construction (Tolppanen et al. 2013, p. 16). Some model houses were built with special permits already in 1996-1997 in e.g. Tuusula and Raisio, and the good experiences from these projects lead to loosening regulation and allowing WMC in broader scale in 1997 (Tolppanen et al. 2013 p. 16-17).

However, loosening regulation did not immediately lead to an industrial breakthrough, since only eight wooden apartment blocks were constructed between 1997 and 2006 (Tolppanen et al. 2013, p. 17). After weakened interest towards WMC in the mid 2000's, the promotion of WMC restarted in 2009 due to good experiences in Sweden and the interest of forestry companies to develop the systems in wooden construction (Tolppanen et al. 2013, p. 18). WMC has gathered interest also outside Finland and especially Sweden, Norway, Great Britain, Canada, the US, Germany, Austria and Switzerland have distinguished themselves as countries, where WMC is being executed and developed (e.g. Tolppanen et al. 2013, p. 20-26).

Technical solutions available in WMC are varied and include for example modular building and beam-and-column systems, whereas wood products used in these systems include e.g. sawn timber, cross-laminated timber (CLT), laminated veneer lumber (LVL) and glulam. Carbon emissions and especially energy use vary between different building systems, and Dodoo et al. (2013) showed that the lowest production and operation primary energy use and the greatest end of life energy benefit are achieved

with the CLT building system when compared with beam and column and modular building systems. The number of construction companies and material suppliers in the WMC industry is still quite small, but new companies such as CLT manufacturer CLT Plant, who started delivering CLT to the Finnish market in 2018, have entered the industry (YLE 25.6.2019).

Building with wood has also advantages other than low emissions and energy-efficiency that make it interesting for different stakeholders. First of all, an organization that aims to enhance wooden construction claims that wood is an interesting material for architects and construction companies since it is a dimensionally accurate, light but durable material, which is easy to work with (Tolppanen et al. 2013, p. 31). Swedish architects and engineers perceive strength, environmental friendliness, simple handling and appropriateness for use in conjunction with industrial methods as the positive aspects of wood (Roos et al. 2010). In a study by Hemstrom et al. (2011), the overall attitude and interest of Swedish architects towards wood as construction material was positive and they perceived that wood performs better than steel or concrete in the following aspects: work environment, transport, climate impact, sustainable development, energy use during construction, ease of recycling materials and ease of renovating/demolishing the building, whereas energy efficiency of the building was perceived as the same with steel and better than with concrete. However, architects perceived concrete as a better frame material for multistory buildings due to perceptions of its better stability, fire safety, durability and acoustic properties, which influence the frame material choice more than the other properties listed above (Hemström et al. 2011). Anyhow, the positive attitude of architects towards wood may not further the market diffusion of WMC much, since architects and engineers find their possibilities to influence material selection weak and see that developers and contractors have more power to make the material selection (Roos et al. 2010; Hemström et al. 2011).

Second, wood is an interesting material for investors in the rental apartment markets since rental income will begin to accumulate sooner due to shorter construction time. This enhances profitability due to time value of money, i.e. a sum of money received now is worth more than the same amount received in the future. Receiving returns earlier could potentially make WMC profitable even if it was more expensive than

conventional construction, and the topic has perhaps not been researched or considered enough yet.

Third, wood could be attractive for consumers due to the positive properties and mental images related to the natural material; residents of wooden buildings generally find their homes comfortable and are satisfied with air quality and fire safety (Karjalainen 2002). Toppinen et al. (2013) found that environmental sustainability of wooden products in housing and the social acceptability of the products can be associated with a specific consumer lifestyle. However, the demographic features that describe the consumers interested in this lifestyle seem to vary in different studies: in the study of Toppinen et al. (2013), the environmentally more sensitive consumer segment was characterized by relatively old age, female gender and the ownership of a summer cottage, whereas Høibø et al. (2015) found in a Norwegian study, that it is younger people with strong environmental values that are the best target for increasing WMC.

However, even though sustainability is important for certain consumers, the majority does perhaps not find environmental aspects the most important attribute in the decision-making about housing. Consumers might also not be sufficiently aware of the environmental benefits of wood and thus could not take them into consideration in their decision-making, so raising public awareness of these benefits might be a way for the WMC industry to increase consumer demand for WMC. Indeed, Riala and Ilola (2014) suggested that customers do not have very strong preferences towards the choice of frame material, but again they did not consider how conscious the customers were about the benefits of wood. Nevertheless, according to Høibø et al. (2015), the opportunities of wood to gain market share will increase as environmental awareness will generalize and more consumers will start to look for environmentally friendly product alternatives. Also Toivonen and Viitanen (2015) came to the conclusion that search of meaning, defined as the appreciation of "softer" values such as silence, nature and personal wellbeing, will gain importance in the future real estate market, and wooden construction could well answer to this demand.

WMC has been studied both in Finland and abroad, and the number of studies concerning WMC has been increasing especially during the last few years. At first, research about WMC included mainly technical studies and emission calculations (e.g. Gustavsson et al. 2010), but recent research includes topics such as end-user

perspectives on wood in housing and business ecosystems in WMC, both topics studied by the KäPy – Taste of Wooden Living research group in the University of Helsinki. However, research from the viewpoint of construction companies is scarce. Especially reliable information about the costs and profitability of WMC is hard to find, and cost figures presented in newspapers (e.g. Rakennuslehti 18.11.2016) are rough, one-sided estimates at best. Profitability is a topic worth studying in more depth if WMC is wanted to gain market share and also the constructors have stated that a mere ideology is not a sufficient incentive to build with wood, but the construction must be beneficial for the constructor and also the end-user (Ijäs 2013, p. 187).

1.2 Purpose of the study

Several national and multi-national political actors have set targets for increasing the share of WMC to decrease the environmental impact of the construction sector, but it seems that these targets will not be met by continuing the business-as-usual (Hurmekoski et al. 2018). The number of companies that have completed WMC projects is small, and these companies also have experience from only a limited number of mostly pilot projects. New actors would increase the capacity of WMC and create competition, which could drive companies to develop their practises to be more cost-efficient and thus enhance the competitiveness of WMC compared to construction with other materials. However, there is a lot of uncertainty and little research about the profitability of WMC. Examining profitability is important, since a company's purpose is ultimately to generate profit to its owners. Companies interested in entering the market are naturally interested in also the future prospects of the industry, as potential for growth and profit is what lures businesses to new market areas.

Therefore, objective and reliable research about the current and future profitability of WMC is needed in order to attract new actors to the industry and increase the share of wooden construction. The aim of this thesis is to examine industry professionals' perceptions about the current cost level in WMC and to find ways to enhance the profitability of WMC in the future. The scope of the research is Finland, and any figures presented after this are for Finland if not otherwise specified. Research questions this thesis tries to answer are:

1. What are the perceptions of experts of the WMC industry on the current cost level in WMC?
2. Which factors affect the profitability and market share of WMC?
3. How could the profitability of WMC be improved in the future?

2 Conceptual Background

This chapter presents factors affecting the profitability of WMC and ways of improving it that have been recognised in earlier research. By definition, profitability means a company's ability to generate profit, which is calculated by deducting expenses caused by manufacturing a product or providing a service from the revenues, i.e. income from selling the product or service. Profit is an absolute amount while profitability is a relative one, meaning that it displays the company's ability to generate profit in relation to its size. Profitability can be measured by gross margin ratio and profit margin ratio, for example.

Finding out explicit profitability measures and analyzing them is difficult, since cost data from individual building projects is confidential and companies are reluctant to hand it out to researchers. Hence, the analysis of profitability is here divided to analysis of the factors that affect it, mainly costs and revenues since these are what form profit. History of WMC, legislation regarding building with wood as well as forecasts of the construction sector are also briefly presented, as they are essential for understanding how WMC has developed and what kind of future possibilities, especially related to improving the industry's profitability, it might have. Furthermore, barriers for the market diffusion of WMC and considerations about the industry's future are introduced, since they affect the decision-making of companies already operating in the industry and those interested in operating in it.

2.1 Legislation

Legislation is important for both the market diffusion and profitability of WMC, as restrictions set by legislation can complicate WMC and also create additional costs compared to other materials. Fire safety requirements have restricted the story number and height of wooden framed buildings and therefore hindered the progression of WMC industry, even though legislation has been considerably loosened during the last 20 years. Until 1997, the National Building Code allowed using wood as a load bearing structure and as a main material in façades in buildings with only one or two stories. Regulation was loosened in 1997 to allow the construction of 3-4-story wooden framed buildings with a wooden façade with a maximum height of 14 meters. Legislation was revised again in 2011, when building up to 8 stories and 26 meters with wooden frames

was allowed. In 2018 the limits were broadened further, and currently regulations sets the height limit of wooden framed buildings with a wooden façade to 8 stories and 28 meters. In addition to residential and office buildings, this newest building code can be applied to nursing institutions, accommodation buildings such as hotels, commercial buildings and recreational buildings as well (The National Building Code 2017).

However, height is not the only feature of WMC's that is regulated in the National Building Code. WMC's must have automatic fire extinguishing equipment and the standards for the equipment are higher for taller buildings (Tolppanen et al. 2013, p. 137). Furthermore, fire regulation commands that only 20% of wooden frames can be left visible, while the remaining 80% must be covered with for example plasterboard (The National Building Code 2017). Similar to height restrictions, also regulation concerning encapsulating the frame has been loosened from before, since until 2018 all wooden frames had to be fully covered.

Despite the recent changes to legislation, WMC industry stakeholders find the Finnish building codes relatively strict (Hurmekoski et al. 2018). The stakeholders particularly criticize fire regulation for its overlapping requirements of both covering the structural wooden frame and installing sprinklers, which causes additional construction costs (Hurmekoski et al. 2018). These requirements do not apply to concrete construction and thus worsen WMC's competitive position compared to concrete building. Legislation concerning WMC is also not identical between European countries, which can be problematic to exporting companies. WMC industry stakeholders propose that harmonizing European building codes would open major new markets, although this would be possible only after 2030, if at all (Hurmekoski et al. 2018.)

Regardless of the criticism, neither the construction industry stakeholders (Ijäs 2013, p. 166-168) nor academia (Määttä et al. 2016) perceive regulation as the most important factor hindering WMC. In a study by Ijäs (2013, p. 166-168), regulation was the fifth most often mentioned individual barrier to WMC with 16% of developers and engineers saying that it is the largest barrier. Also representatives of building, forestry and wood industries perceive changes in regulation less important than other factors (e.g. standardized building systems) when asked about factors affecting the future competitiveness of WMC (Toppinen et al. 2018a). Furthermore, WMC professionals

fear that changing legislation so that it would favor wood would cause negative publicity, loss of credibility and counter lobbying (Hurmekoski et al. 2018). The barriers to WMC are presented in more detail in chapter 2.6.

2.2 Market share of WMC

Regardless of the loosened regulation, Finland's vast forest resources providing raw material and the political interest towards WMC, the number of completed WMC projects has remained rather small, as stated in the introduction. By the end of March 2019, there were 77 residential wooden apartment blocks with a total of 2098 apartments and four wooden multistory buildings for office use in Finland (Puuinfo 2019). For comparison, there were nearly 1.4 million apartments in apartment blocks in total (OSF 2017b).

Even though the absolute number of apartments in WMC's is still small, its share from all started apartment block construction projects has increased as illustrated in figure 1. Despite the increase, WMC is still marginal: the average share of apartment starts in WMC from all apartment starts between 2010 and 2017 was only 4%.

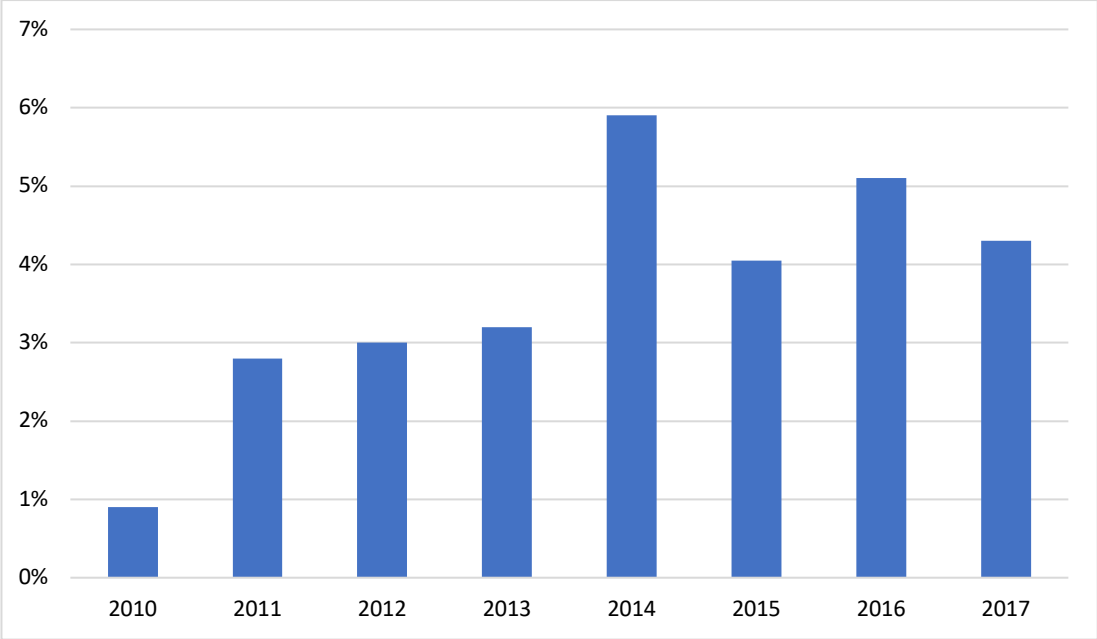

Figure 1. Share of apartments with wooden frames from all apartment starts, 2010-2017. Data from Forecon (2017).

As noted earlier, the Finnish government wishes to increase the use of wood in residential multistory construction in order to reduce Finland's GHG emissions. The use can increase in two ways: either wood substitutes other construction materials and the market share of wood grows, or growth is achieved through the increase of overall construction volume, meaning that the market share of WMC does not necessarily grow but can stay the same or even decrease. Increasing the use of wood in construction might be harder if wood has to claim share from other materials, but it seems that heavy competition with other materials is the only way to meet the targets, since the volume of construction is currently expected to decrease (OSF 2019).

The Finnish construction sector grew consecutively from 2015 to 2018 as illustrated in figure 2, but growth is estimated to end in 2019 and turn negative in 2020. The decline has indeed started in 2019, as the cubic volume of building permits granted between April and June 2019 was 14.6% lower than the corresponding number in 2018 (OSF 2019). Moreover, the decline is especially hard in apartment blocks, as the cubic volume covered by permits for residential apartment blocks decreased by 23.8% (OSF 2019).

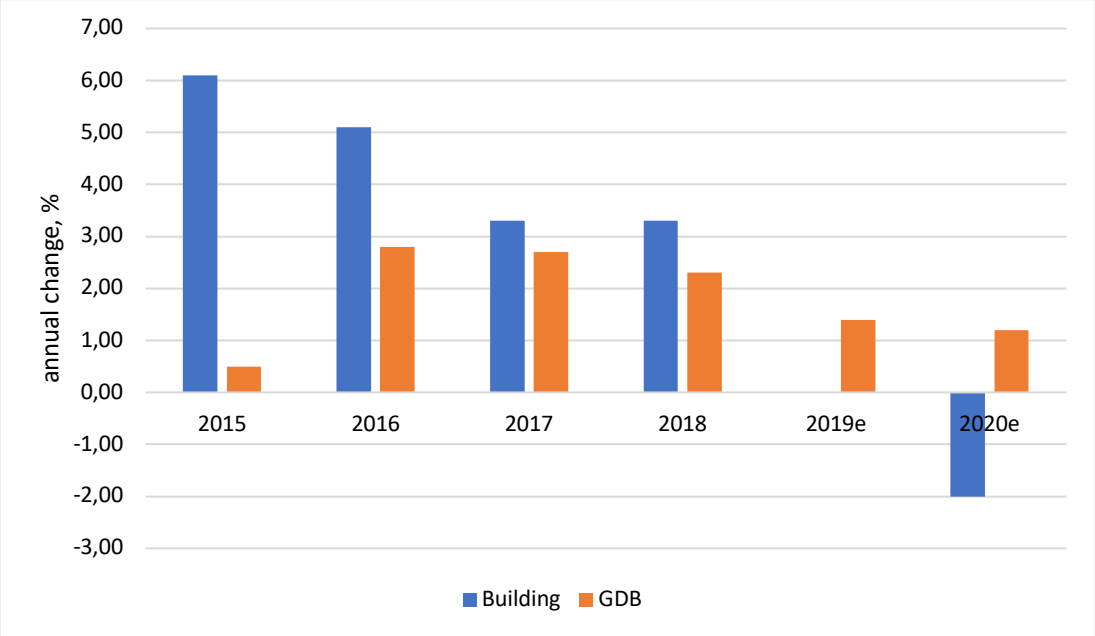

Figure 2. Annual change in construction activity and GDP. Data from Confederation of Finnish Construction Industries (2019).

However, it seems that despite the discouraging outlooks for the construction sector, WMC will increase. In fact, according to a situation assessment by the Ministry of the Environment and Puuinfo (2018), the number of apartments in wooden multistory apartment blocks might multiply in the coming years. The assessment listed all upcoming WMC projects (i.e. houses that have at least three floors and large-scale public building projects) and divided the projects to certain, probable and possible projects based on how likely they are to actualize. According to the assessment, there were 10 certain, 28 probable and 13 possible upcoming WMC projects in November 2018 and the number of apartments in these possible projects was 1100, 5240 and 3670, totaling 10030 apartments. The number of projects had increased from 40 projects in 2017 to 51 projects in 2018.

2.3 Political support to wooden construction

WMC has the support of several governmental and regulatory actors. The Ministry of the Environment launched a Wood Building Programme (2016-2021) under Juha Sipilä's government's spearhead project "Wood on the move and new products from forests". The programme was extended to continue until 2021, past the reign of Sipilä's government. The current government of Antti Rinne, elected in June 2019, has committed to the program and also declared that the use of wood in construction should double between 2019 and 2023 (Finnish Government 2019). The objectives of the Wood Building Programme are to increase the use of wood in urban environment, public buildings and large constructions such as bridges and halls, to strengthen skills bases to enhance wood construction's international competitiveness and to promote exports. The project's objectives align that WMC should grow by 10% annually.

The government also gives financial support for actors in the wood construction industry. As part of the Wood Building Action Plan, the Ministry of the Environment grants a maximum of €2.5 million to projects that either activate interest groups or encourage new players to enter the wood construction industry. In the first application round, support was granted for projects that will promote digitalization in the wood construction industry, while the next two rounds will give grants for developing user-based solutions and enhancing circular economy within the wood construction sector. The program received funding from the government's spearhead project until 2018,

but after the parliamentary election in 2019, the funding of the program moved under the National Energy and Climate Strategy for 2018-2021, where it is mentioned as a way to reduce the carbon footprint of construction.

Moreover, some cities and municipalities have declared their own objectives regarding wooden construction. Pirkanmaa region has stated that 10% of all new apartment blocks and 100% of additional floors constructed on top of existing buildings will be constructed of wood in the future (Metsäkeskus 2019). Some cities also assign individual building lots or even entire neighbourhoods solely for wooden construction, like the city of Helsinki did in the neighbourhood of Honkasuo (City of Helsinki, Urban Environment Division 2008). Betoniteollisuus ry in fact complained to court about the restrictions concerning building materials in the city plan for Honkasuo, but the Supreme Administrative Court rejected the complaint stating that the restrictions were consistent with regulation (KHO 2015).

International stakeholders have also set targets regarding WMC. As mentioned in the introduction, The European Forest Sector Technology Platform (2012), comprised of industry stakeholders, forest owners and public authorities, has set a target of tripling the share of wood-based construction in Europe from 2010 to 2030. Furthermore, 22 out of the EU27 countries have national action plans for enhancing green public procurement related to building (Herczeg et al. 2014). Also the EU has numerous strategies (EC 2012), roadmaps (EC 2010) and flagship initiatives (EC 2014) that promote green building. Regardless of these programs, the environmental performance of building is not fully regulated on EU level, since the programs lack binding targets for embodied carbon, water and non-renewable resources of construction products (Hurmekoski et al. 2018)

2.4 Costs of WMC

Construction costs are a crucial factor for the profitability of a construction company, since costs and revenues are what ultimately form profit and therefore define profitability. Moreover, according to Swedish architects, cost of construction is the largest factor in the choice of frame material in construction (Hemström et al. 2011) and it does not seem likely that construction costs will have any lesser value in the

future, since Toivonen and Viitanen (2015) defined pressure to cut costs of all actions as one of the nine forces of change shaping the future of commercial real estate.

One reason for the slow growth of the WMC industry might be that constructors have perceived the lifecycle costs of WMC higher than those in conventional construction mainly due to the novelty of the industry and therefore the experimental nature of finished projects (Ijäs 2013, p. 180). Numerous studies have also identified cost-competitiveness as a barrier for the market diffusion of WMC (e.g. O'Connor et al. 2004; Roos et al. 2010; Riala and Ilola 2014). In a study by Riala and Ilola (2014), 8 out of 18 construction industry stakeholders thought that WMC is more expensive than using other solutions. Interestingly, in their study, interviewees with most experience from WMC were the most critical towards it and mentioned the most negative experiences and problems towards it. Main reason for the higher costs mentioned by them was lack of experience in building with wood, which results in less efficient processes and under–developed products, followed by additional costs caused by fire regulation and more expensive sound insulation and intermediate floors. Estimations about how much single factors increase the costs have not been presented much in literature, but according to WMC industry stakeholders, fire regulation causes the costs of WMC to rise by additional few percent's (Hurmekoski et al. 2018).

Maintenance costs, such as repainting facades and plumbing repairs, should also be considered when defining the profitability of WMC projects. Maintenance costs can be seen as investments in the building because they increase its value and extend the lifespan of the building. Research about the costs of WMC has concentrated around construction costs (e.g. Riala and Ilola 2014), but the importance of life cycle costing in the construction sector is growing; experts of the WMC industry see it both highly likely (76% of respondents) and highly desirable (100%), that life cycle costing will in the future affect the decision-making in large-scale building projects significantly more than focusing merely on purchase price (Toppinen et al. 2018b). Furthermore, broadening perspective to cover the whole lifecycle of a building (i.e. production, construction, operation, end-of-life and energy supply) is not important only in terms of costs, but also in the evaluation of the primary energy use and climatic impact of buildings (Gustavsson et al. 2010; Dodoo and Gustavsson 2013).

Therefore, it seems that more emphasis should be given to the entire life cycle of buildings and also the maintenance costs of WMC's. Knowledge and research about the maintenance costs of WMC's is, however, scarce and conflicting. Ijäs (2013, p. 193) found out that contractors perceive the maintenance costs in WMC's higher than the corresponding costs in concrete buildings, which makes them unwilling to invest in WMC, but according to Tolppanen et al. (2013, p. 176), the overall maintenance costs in WMC are at the same level as in houses built with other materials. However, comparisons to concrete buildings are hard to make since the number of finished WMC projects is low, the buildings are relatively young and the main sources of maintenance costs depend much on the material used. With wood, especially wooden facades increase maintenance costs, as they require maintenance more often than concrete facades.

Despite the presumably higher construction costs in WMC mentioned above, there is also potential for cost savings in WMC caused for example by the lightness of wood, fastness of construction and the possibility to use waste from the processes for energy. According to Tolppanen et al. (2013, p. 176), the most important competitive advantage of WMC is fastness of construction. Construction time is also one of the main criterions in choosing construction materials: Swedish architects named it the third most important factor affecting the choice of frame material (Hemström et al. 2011). Fastness is achieved with industrial construction, where components are prefabricated indoors and only erection is done on the construction site. Tolppanen et al. (2013, p. 174) claim that WMC can be up to 50% faster than conventional construction when prefabricated building blocks or modules are used. Shorter construction time decreases overhead costs, as less money needs to be spent on wages and keeping the equipment on the construction site (Tolppanen et al. 2013, p. 176). Hurmekoski et al. (2018) also state that the best ways of increasing the value added in the woodworking industries are industrial prefabrication methods and developing and harmonizing building codes and standards.

Fastness together with dryness of construction and lightness of the material were the most often mentioned positive experiences of WMC also in the interview study of Riala and Ilola (2014). Lightness of wood decreases construction costs, since less fuel is needed in transport and lighter and less expensive cranes can be used on the construction site (Tolppanen et al. 2013, p. 176).

Learning from repeated projects and economies of scale accomplished by increases in production volumes could also decrease the costs of WMC. WMC is such a new branch in Finland that actors in the sector have not yet been able to develop their products as good and processes as smooth as those in conventional building, where routines and procedures have been improved during decades of production (e.g. Riala and Ilola 2014). According to experts of the construction industry, ways to enhance the cost-effectiveness of WMC include improving the knowhow of timber construction, prefabrication, building more timber buildings, changing building or fire regulations and increasing standardization (Riala and Ilola 2014). Tolppanen et al. (2013, p. 176) also mention, that including carbon footprint calculations to the standards that create costs could enhance the competitiveness of WMC.

2.5 WMC as an investment

Analyzing the profitability of WMC as an investment requires considering the revenues of WMC and costs addressed in the previous chapter. Revenues in construction consist of rent or selling price and capital appreciation. It is difficult to say if apartments in wooden buildings could yield more revenue than apartments in buildings from other materials since the topic has not been studied adequately, but research has shown that consumers might be willing to pay premiums for products that have higher environmental quality (Toppinen et al. 2013; Hansmann et al. 2006). However, also conflicting results have been presented; in a study by Riala and Ilola (2014), some construction industry experts specifically stated that customers are not willing to pay more for environmentally friendly construction. The willingness of consumers to pay for sustainable construction should be researched more, as should the impacts of shorter construction time on the revenues in WMC.

The lifespan of buildings is also a matter that affects revenues, since a shorter lifespan would mean that revenues accumulate for a shorter time. Uncertainty considering the lifecycles in WMC might restrain companies entering the industry, since there is no proven knowledge about the lifecycles in WMC due to the novelty of the industry. However, the material of the main structure might not have such a large effect to the lifespan of a building at least according to a study by the Athena institute (2004), which

showed that degradation of the main structure is rarely the reason for demolishing a building.

A perhaps interesting speculation about the revenues of WMC is the possibility for government subsidies for apartments in WMC's. Citizens have increasingly demanded politicians to reduce Finland's greenhouse gas emissions in for example the worldwide climate strikes, and subsidies for sustainable products and services belong to the government's means of supporting emission reductions. Subsidies are already in use for certain sustainable products like electric cars (The Ministry of Transport and Communications 2018), and similar subsidies could be offered for wooden construction in the form of e.g. subsidies to rents in wooden houses or compensations for companies building with wood. Subsidies for WMC have also been mentioned by industry stakeholders as a way to reduce the costs of WMC and make it more competitive; 76% of WMC professionals wished in a study by Hurmekoski et al. (2018) that environmental externalities would be accounted in the prices of raw materials and commodities.

2.6 Barriers to WMC

As stated before, the WMC industry has grown rather slowly, and research has identified multiple barriers that have hindered the growth of the industry. One of the most often mentioned barriers is the strong path dependency of the construction sector and concrete building networks (Mahapatra and Gustavsson 2008, Hemström et al. 2017). The traditional organizational cultures and project-based structures in the construction sector have hindered innovativeness (Kadefors 1995), which delays achieving the societal objective of sustainability (Matinaro and Liu 2017). Hurmekoski et al. (2018) further claim that socio-technical path dependencies will lessen the impact of the construction markets' trends, such as the need for reduced embodied energy and carbon towards 2030, particularly because of cultural reluctance for change and risk aversion of the industries. These path dependencies combined with the objective to minimize risks and costs also mean that lesser weight is given to customer preferences (Hemström et al. 2017) and result in barriers for adopting unconventional approaches such as WMC in construction, as dominant technologies are perceived the best at delivering the expected market returns (Jones et al. 2016).Likewise, Nordin et al.

(2010) specifically state, that WMC market diffusion is likely greatly affected by the traditions and patterns of behavior in the construction sector.

Besides the traditions of the construction sector, barriers to WMC include for example lack of knowledge, attitudes and technical issues as well as legislation and cost factors, which were already discussed in chapters 2.1 and 2.4. Attitudes as a barrier for WMC are strongly linked to the path dependencies of the construction sector, but the choice of word perhaps describes and emphasizes more the perceptions of individual stakeholders than the shared beliefs and ways of working in the industry. Ijäs (2013, p. 166-168) found that according to developers and structural engineers, the largest individual barrier to WMC was appreciation and attitudes, which was named as the largest barrier by 22% of respondents. This category included also the long traditions in concrete building. The next largest barriers were lack of knowledge and information (20% of respondents named it as most important), technical aspects (17%), cost factors (16%) and regulation (16%). Also Määttä et al. (2016) raised attitudes as the main bottleneck for WMC, followed by the lack of knowledge. Likewise, lack of knowledge was pointed out in a study by Toppinen et al. (2018a), where interviewees of the WMC sector stated that WMC is still at a very early stage and that the lack of experience and positive examples is a problem for the companies operating in the field.

Different studies have divided the barriers to various measurable and immeasurable factors. For example, Giesekam et al. (2014) divided the barriers of adopting lower embodied carbon technologies, practices and materials to institutional and habitual, economic, technical and performance-related as well as knowledge and perceptions. Furthermore, Giesekam et al. (2014) specifically stress that at least the UK lacks sufficient client and regulatory drivers of change for adopting sustainable technologies and states that the responsibility for emission reduction is not effectively allocated within the industry.

Construction industry experts have also suggested that wood products industry should take more responsibility in developing and enhancing WMC and not blame the construction companies for not adopting unfinished techniques or materials. For instance, in a study by Toppinen et al. (2018a), WMC industry experts pointed out that contractors are indeed interested in bringing solutions to the market but not willing to develop them themselves and emphasized that the wood industry should be the one to

validate wood-based building solutions. Also, the fragmented structure of the wood products industry was seen as a problem in a study by Hurmekoski et al. (2018), since the mostly small and micro firms operating in the wood products industry in Finland lack sufficient know-how and capital needed to enhance WMC in the demanding Nordic markets.

Furthermore, studies have identified problems but also possibilities in the marketing of WMC. Regulation and general attention related to climate change is seen as the driving force in the growing popularity of WMC, but experts of the WMC industry do not believe that the ecological nature of wood as construction material is currently captured well enough and utilized sufficiently in WMC marketing and communication (Toppinen et al. 2018b). Interestingly, Toppinen et al. (2018b) also gained indicative results of personal health benefits outweighing generic environmental benefits as the main rationale for choosing to live in a wooden building, which should perhaps be emphasized to a greater extent in the marketing of WMC. However, even though health benefits might be important for consumers, WMC industry representatives are not confident that the potential positive impact on human health and the functional qualities of wood (e.g. hydrothermal, acoustic, antibacterial) could provide any significant competitive advantage to companies operating in the field in the short-term (Hurmekoski et al. 2018).

2.7 Future perceptions

Perceptions about the future of WMC affect the decisions of companies already acting in the WMC industry and those interested in entering the industry. According to Toppinen et al. (2018a), WMC industry experts are fairly confident that the use of wood in construction will increase in the future. However, they do not fully trust in the transformative power of changes occurring within the WMC sector (Toppinen et al. 2018a) and the market diffusion of WMC does not look very probable in the coming years mainly due to the barriers mentioned previously (Hurmekoski et al. 2018). The next paragraphs introduce previous research about overcoming these barriers in order to achieve market diffusion.

One way for the market share and profitability of WMC to increase would be through increased consumer demand. In a study by Toppinen et al. (2018b), WMC experts

believed that growing demand for green building and sustainable living will make sustainability a megatrend in housing and that competitiveness of WMC could improve significantly through growing consumer demand. Also Hemström et al. (2011) state that emphasizing environmental performance in material selection either through consumer demand or policies could improve the prospects for wood frames.

However, the discussion about consumer demand and preferences has also controversial features, since construction industry stakeholders claimed in a study by Riala and Ilola (2014) that consumers do not have strong preferences on frame materials. Furthermore, mere sustainability has not influenced material selection in construction much at least until the beginning of this decade, since in a study of Swedish architects, climate impact and sustainable development were only on ranks 12 and 13 of factors that affect the choice of frame material (Hemström et al. 2011).

Thus, in order for WMC to achieve market diffusion, those pursuing it should perhaps not trust only on consumer demand as a driver for the growth of the industry, but rather try to become competitive on the industry's own terms. In fact, WMC industry experts believe, that wood will have become a competitive construction material by 2030 (Toppinen et al. 2018a). The factors affecting the competitiveness of WMC have been studied to some extent and the next paragraphs present the findings of these studies.

According to Toppinen et al. (2018a), the most important internal factors influencing the competitiveness in WMC were speed of construction, standards and standardized product systems, cost efficiency and co-operation, whereas the most important external factors were improving know-how, influence from city planning, building regulations, R&D and demand for WMC via public procurement. Toppinen et al. (2018a) stated that skilled architects and builders as well as standardized building systems are especially important in improving the competitiveness of the WMC sector, whereas Riala and Ilola (2014) stressed the internal factors and concluded that lightness, speed of construction and prefabrication are the best possibilities for wood to compete on its own terms. Tolppanen et al. (2013, p. 174-177) also emphasized the fastness of WMC and argued, that WMC can become even faster in the future by developing the logistics of WMC and completing multiple attractions with the same crew, which creates time-saving routines. Haapio (2013) in turn stressed the

importance of research, succeeded reference projects and product development as ways to increase the use of wood in construction.

Researchers have also highlighted collaboration, networking and organizational changes as means to enhance the competitiveness and profitability of the WMC sector. For example, Toppinen et al. (2018a) concluded, that developing technical infrastructure and project-based business networks are in a key role in improving the competitiveness of WMC, and that also cross-sectoral collaboration and business networks between players are needed. Also Nordin et al. (2010) paid attention to collaboration and networks in their case studies about Swedish timber housing companies and concluded that the currently niche WMC industry could be broadened by re-structuring WMC business networks. Organizational changes were also seen as a better way to increase the value added in the wood products industry than cost reductions by Parvinen et al. (2009).

Political means have also been mentioned as a way to increase the market share of wooden construction. Hurmekoski et al. (2018) studied the means to achieving the long-term targets for green building and found that the goals could be achieved either by increasing competition and credibility among construction professionals or by establishing more direct policy support means. Political means were found to be more efficient, but industry stakeholders found them unattractive. Instead, stakeholders wished that risks of WMC would be lowered by successful reference projects and standardization of wood-based construction elements, which would increase competition. The authors also concluded that the authorities might need to use new means of promoting the business opportunities in green building.

The first two chapters of this thesis introduced the concept of WMC and previous research related to the profitability of it. Next chapters present the methodology and results of this study and finally the results are linked to previous literature.

3 Data and Methods

3.1 Semi-structured theme interview method

This study was conducted by qualitative semi-structured theme interviews with professionals of WMC. When the aim of the research is to examine novel topics with little prior research and find new points of view like in this study, the research method is most often qualitative (Hirsjärvi et al. 1997, p. 129). Interview was chosen as the method, since it enables combining the thoughts and experiences of multiple players in the field and thus forming a general view of the situation. Interviews are especially good for researching areas where the amount of previous research is modest (Hirsjärvi and Hurme 2004, p. 35).

Semi-structured interviews are set between structured and open interviews. They do not follow a strict, predesigned questionnaire like structured interviews do, but rely more on free discussion about themes that are decided and thoroughly prepared beforehand. The questions are most often open-ended unlike in structured interviews, where also response options are limited. In comparison, open interviews do not follow any structured questionnaire, not all interviewees need to answer to questions about all the same themes and the role of the interviewer is very important as an active partner in the discussion. (Eskola and Suoranta 1998, p. 86)

Since interview questions are not tightly limited in semi-structured interviews, there is room to discuss quite freely also about topics that emerge during the interview. Some aspects might be such, which the researcher has not thought of when planning the interview, and the free format of semi-structured interviews allows the researcher to focus also on these. This reduces the risk of missing some important aspects due to restrictions to topics set by a strict questionnaire like in a survey or a structured interview, where the questionnaire might not include all the relevant questions, thus leading to incomplete results (Hirsjärvi and Hurme 2004, p. 37).

Theme interviews require active participation and preparation from the interviewer, since they need to react to the answers of the interviewees and direct the conversation without relying too much on pre-defined questions. However, they should

simultaneously be neutral and not state their own opinions or argue with the interviewees (Hirsjärvi and Hurme 2004, p. 97). Personally, I found that it is very important that the interviewer is well prepared for the interviews and familiar with the topic, so they can ask the right questions that will provide new insight. Also, interviewing professionals about a topic like WMC requires sufficient background knowledge about the subject from the interviewer, so that time is not spent with the interviewee explaining the basics about the topic but the participants can discuss on a deeper level from the start.

3.2 Data

3.2.1 Number of interviews

The data consist of six semi-structured theme interviews. The respondents represented construction companies, element suppliers, a contractor and an organization whose aim is to advance the wood construction industry. Titles of the interviewees include for example CEO and Director, Sales and Development. All interviewees were male.

The sample of six was found to be large enough considering the limitations and purpose of this study. The same opinions and proposals arose in many of the interviews, and there were only a few things that were mentioned by only one of the interviewees. Thus, adding the number of the interviewees would not have necessarily given this research any new information, which is called saturation of the data (e.g. Eskola and Suoranta 1998, p. 62). Furthermore, as WMC is a new and still marginal method of construction and there are not that many companies that have built or ordered wooden multistory apartment blocks, the number of possible interviewees that fulfilled the requirements was not overly big and these six interviewees represent the defined target group of this study well. Also according to Hirsjärvi and Hurme (2008, p. 59), when a study does not aim for statistical significance but is a qualitative study like this one, even a few interviews can provide enough data to create a deep understanding of a phenomena and to find new theoretical views.

3.2.2 Data collection

Possible interviewees were identified during a literature search for newspaper articles about WMC and existing contacts of the sponsor of this study, Dasos Capital, were also utilised. As is typical for qualitative studies (Hirsjärvi et al. 1997, p. 155), participants were chosen by purposive sampling, meaning that the researcher relies on their own judgement when choosing participants to a study instead of using probability sampling techniques. Furthermore, it was assumed that the number of possible interviewees that fulfil the requirements would be too small for probability sampling techniques. The requirements set for the interviewees were that they:

1) are in a decision-making, senior level position in their company and

2) have experience about WMC from some point of the supply chain; either as a contractor, element supplier, or a client.

Nine suitable persons were recognized quite easily and interview requests were sent to them by email at the end of November 2017. The response rate was relatively high: of the 9 invitations sent, 6 agreed to do the interview and 3 left the invitation unanswered. The three persons that did not answer were not contacted again, since a sample of six interviews was found satisfactory.

The relatively high degree of participation might be due to the funding of this thesis by Dasos Capital, which was mentioned in the emails where interviews were requested. Two of the interviewees had already been in some kind of contact with Dasos Capital and some of the others might have wished for an opportunity to co-operate with them in the future, which might have motivated them to participate in the interviews. Furthermore, the respondents might have hoped that this study would prove that WCM was cost competitive now or could be in the future, which could make new investors and clients interested in WMC. The thesis could this way be helpful for the interviewees and perhaps make them more willing to participate. Motives of the interviewees are linked to reliability and validity of the study, which are discussed in chapter 5.2.

3.2.3 Interview questions

As the interviews were semi-structured, some questions about the themes of this study were prepared beforehand but they worked mainly as guidelines and starting points for conversation and left space for emerging questions. Theme interviews do not require the questions to be asked in a particular order and all interviewees do not have to answer all the same questions, as long as all themes are discussed to some extent (Eskola and Suoranta 1998, p. 86). In this research, the interviewees had different backgrounds and experience of WMC and therefore the questionnaires were personalised for each interviewee based on previous knowledge of the company they presented and WMC projects they had participated in. Initially, the areas of interest in the interviews were divided to three themes:

1) Costs

2) Revenues

3) Finance

A general plan for the research questions is presented in Appendix 1. The three themes represent the initial areas of interest in this study. However, the study's focus had to be switched after a few interviews were held, as it became evident that discussions about some of the predefined themes did not reveal much new information, whereas other themes provided to be more fruitful. At first, the main topics of interest were the current cost level and availability of financing to the companies, but as it turned out, the interviewees could not reveal any exact cost figures and did not have much experience about financing. Instead, they had a lot of thoughts about the future development of the industry and how profitability of WMC could be enhanced, and therefore the research questions were specified during the analysis of the results to have a bigger emphasis on future development. This was possible, since qualitative research leaves room for research questions to develop during the research, as suggested by Maxwell (2009).

Each theme included several questions, but as the interviews resembled more free discussion than a structured interview, the prepared questions worked mainly as a support list for the interviewer. Some questions, like the question about the current cost level in WMC, were more strictly defined and also answers to these were quite direct and unambiguous. However, some questions or themes were commented in

many parts of the interviews, and these separate comments had to be united in the analysis of the data to find out what the holistic view of the interviewee was to these questions. Especially the ways of advancing WMC arose also in answers to other questions.

3.2.4 Interviews

The interviews were held in November and December 2017. All interviews were held in Finnish and recorded using mobile phone with the permission of the interviewees. Four interviews were held at the offices of the interviewees, one was held at the office of Dasos Capital and one was held in Skype due to long distance between the interviewer and the interviewee. Jenni Laininen, who worked as an Investment Manager at Dasos Capital at the time and was the instructor of this thesis at the company, was present in one of the interviews but the rest of them were held with only the interviewee and the interviewer. The duration of the interviews ranged from 30 minutes to an hour.

The interviews started with an introduction of the thesis and the interviewer, after which the interviewees introduced themselves and their experience of WMC shortly. After this, the interviewer led the discussion so that all themes were handled. The interviewees had different personalities and perhaps different perceptions about what kind of a situation the interview is, and so all interviews were different considering how much and how the interviewer took part in the discussion. With some, the discussion resembled more a normal dialogue with the discussion flowing naturally from one theme to another, while some interviewees were perhaps more reserved and the answers were shorter, which made it harder to continue smoothly from one topic to another. Despite this, the atmosphere in all interviews was quite relaxed at least from the interviewer's point of view, and it felt like there was a sense of trust between the interviewer and the interviewee.

All interviews were transcribed word to word shortly after the interviews, excluding only some confidential parts. According to Hirsjärvi and Hurme (2008, p. 185), the quality of the interviews is better if the interviews are transcribed as fast as possible.

3.2.5 Data analysis

The aim of analysing qualitative data is to condense and combine the data to a distinct form, which provides new information about the topic of research (Eskola and Suoranta 2008, p. 137). The results of this study were analysed with qualitative content analysis, which is often also called thematic analysis. However, thematic analysis mainly refers to classifying the data under certain themes, while content analysis means that the data is condensed and analysed to find similarities and differences in the data (Tuomi and Sarajärvi 2009, p. 93-110).

The analysis was done inductively as opposed to doing it deductively, which is typical for qualitative research (Hirsjärvi et al. 1997, p. 155). Inductive analysis means that the data is analysed objectively based on the research questions and the results are then linked to existing theory, rather than letting existing theory lead the analysis like in deductive analysis (Tuomi and Sarajärvi 2009, p. 95).

As it is very important that the researcher knows the research material thoroughly (Eskola and Suoranta 2008, p. 151), the analysis of the results started with reading the whole transcribed material through multiple times. This helped to get an overall image about the data and to recognise themes, to which the results could be categorised into. The data were read through also later during the analysis to ensure that the results presented the data truthfully and did not concentrate too much on things that were not discussed in depth in the interviews.

Thematic analysis was used to organize the transcribed material to separate MS Word documents according to distinctive themes, like maintenance costs and construction time. This way the answers of all interviewees to the same question could be condensed and analysed more easily. However, as mentioned already in chapter 3.2.3, thoughts about questions like “How do you think the competitiveness WMC will develop and why?” could be found in many parts of the interviews and it would not have made sense to detach these comments from their context to a separate file, since context influenced how these comments should be interpreted. Therefore, analysing these broader questions was more difficult and required making interpretations and connecting comments from many parts of the interviews. Making lists of things mentioned in the interviews together with notes made during the interviews were used to help in the analysis of these questions before the final results could be formed.

The formation of the final results required a holistic view of the interviews and interpretations justified and verified with separate comments. The analysis required returning to the interviews multiple times and checking that the interpretations were consistent with the answers of the interviewees. The analysis is interaction between the researcher and the data, and the researcher affects the results (Ruusuvuori et al. 2010, p. 9-11). Being aware of their role and describing how the results were derived from the data improves the reliability of the results, which is discussed in chapter 5.2.

4 Results

The following analysis of the interviews is divided between the current situation and future development of WMC. First, the current situation is introduced, focusing on the current cost level and profitability including construction and maintenance costs and differences in construction time compared to conventional construction. Second, the views of the interviewees on future development are analysed including an introduction of means to decrease costs and develop the industry in the future. Illustrative citations from the interviewees are written in italics.

4.1 Current cost level

The first research question of this study was "what are the perceptions of experts of the WMC industry on the current cost level in WMC?", and therefore all interviewees were asked about their opinions on the current cost level of WMC. Four of the respondents answered, that building multistory apartment blocks is currently more expensive with wood than with concrete. They could not give accurate numbers since they are commercial secrets, but they gave numeric estimations that varied from 3% to 20%. One of the interviewees thought that the costs are at the same level, and one was uncertain about the level of the costs and stated that the general unawareness of the costs is his main concern since clients would want proof from finished projects.

Comparing costs between wood and concrete or even single WMC projects is complicated, since costs depend greatly on the decisions that the planner and construction company make and differ according to techniques, materials, companies, geographical locations etc. Furthermore, two of the interviewees mentioned that many of the WMC projects currently completed are prototypes or flagship projects where the companies have intentionally chosen expensive solutions and materials, which makes comparisons to concrete insensible.

> *"Basically all WMC's built in Finland are prototypes, meaning that they are all planned for the needs of this one building, and then there can also be some status value on the building, that it has been made a little special and ambitious and sort of a flagship for wooden construction, they are more expensive than concrete construction"*

The interviewees also contemplated the role of public support in the conversations about costs. One of the interviewees argued, that since most of WMC projects are funded by The Housing Finance and Development Centre of Finland (ARA), and ARA does not accept higher costs for wooden construction than for other techniques, the costs for the client must be the same. However, he later added that ARA does not act completely transparently, and that in practice it defines its level of support individually for each construction project. Another interviewee also argued that ARA does support WMC by accepting higher costs from them.

The next sections will cover the comments of the interviewees about the current cost level and matters affecting it. The analysis does not differentiate or compare materials and techniques much, since the aim of this thesis was not to find the most cost-effective way to build with wood, but to examine the overall cost level and profitability of WMC. To add, it would not have been sensible to state that one technique is better than the others based on these interviews, since the sample is small and only covers one or a few companies using the same techniques.

4.1.1 Reasons for higher cost level

The discussions about the costs of WMC also yielded responses to the second research question, "which factors affect the profitability and market share of WMC?". The reasons that the interviewees gave for the higher cost level in WMC included limited experience, low number of actors, location, planning and tendering.

According to the interviewees, the main cause for higher costs is limited experience of the constructors. Two of the interviewees even mentioned that companies add additional risk to their calculations due to the novelty of the industry. According to one of them, the lack of established ways of making contracts and uncertainty about the division of risks and costs cause costs to overlap. Another interviewee argued, that while the techniques in the element factories still require refinement, even more improvement is needed in operations at the construction site.

Difficulties also occur because of lacking practises and unfamiliar ways of negotiating tenders. One of the interviewees gave an example of an undergone project, where the company had tried to get an offer for a property with regular competitive tendering, but did not succeed to get an offer with costs low enough for any building technique

of WMC. The process proceeded only when the client made contacts within the industry and negotiated a contract with one company that would drive the project forward. The building was designed so, that they checked after each step if the costs were on an acceptable level, and if not, required changes were made. According to the interviewee, the final design of the building was a result of many compromises and the costs were within the required limits even though the contractor did slightly exceed their cost estimate. According to the interviewee, the excess costs in this particular project resulted from lack of experience on the contractor's side and challenges caused by the building lot.

In the above example, the contract could only be made after the company collaborated with an element supplier to plan the site. Also another interviewee mentioned that the low number of material and element suppliers in the field causes problems, because materials of different suppliers are not compatible. This means that the project cannot be tendered the conventional way, but the material supplier must be decided before any planning can begin, as in the above example. Therefore, according to the interviewee, there is not enough pressure for the supplier to decrease costs once they have gotten a project, and the supplier must be a company that the client trusts. One interviewee also mentioned, that it is possible to get the best price to quality ratio with competitive tendering and another one claimed, that tendering is the traditional way of seeking for competitiveness and that since this is currently not possible in WMC, the companies operating in the industry should find other ways for increasing their competitiveness.

> *"The problem of wooden construction at the moment is, that unlike other construction, it is based mainly on company-specific systems and this way the possibilities for competitive tendering are different than otherwise, for example in concrete construction. In concrete construction, everyone knows how to build and everyone builds with the same style, and you can in every attraction tender every part with as many actors you want, and this is the traditional way of seeking for competitiveness. This does not work in wooden construction, which is why something else is needed for wooden construction."*

However, one interviewee had a different opinion and emphasised that he does not believe that there is a significant difference in costs even though materials cannot be tendered, but continued that it was anyhow a lousy starting point for competition.

When asked about single cost factors that might be higher than with concrete, the most often mentioned cost was the cost of planning, mentioned by four interviewees. One of the interviewees claimed that wooden buildings require in general more planning than concrete buildings, whereas another interviewee said that planning itself does not cause that much costs, but the decisions made there affect the overall costs considerably.

> *”Planning itself is a relatively small cost in the big picture, but the decisions made in planning cost […] on-site construction should be minimized, since it is a fact that construction in a factory is considerably cheaper than on-site, so when the elements are prefabricated when they are taken on-site, it brings large savings when you do not have to construct so much on-site. So, planning or the cost of planning in itself is not so significant, more the way it is planned.”*

Another problem that arose in the interviews was that there are not enough companies in the industry and therefore not enough competition. However, the respondents also mentioned that a high number of WMC constructors does not help, if clients do not order WMC’s.

> *“From the perspective of a constructor, we have too little supply, we do not have enough actors, enough competition in the sector, it is sort of a problem that there is no supply. But when you ask a wood products manufacturer, they have it the other way around, they have no demand”.*

> *“We need constructors, but even if we had constructors, we will not get WMC’s if clients do not want them. So there is the largest, I do not know, resistance, but there is not enough will.”*

One interviewee also mentioned weather shelter and sprinkler costs as cost-increasing factors in WMC, but even he did not see them having too much of an effect on profitability and stated that comparing single cost factors between different techniques is not reasonable.

The interviewees were not specifically asked if there were any individual costs factors that would be smaller than with concrete, but one of the interviewees mentioned that wooden buildings require considerably less finishing than concrete buildings, which can easily save 50€/m^2. Another interviewee said, that it might be easier or cheaper to get a property for WMC than other types of construction in some municipalities that favour WMC, which would decrease costs. However, another interviewee commented,

that only few properties are appropriate for WMC at least when it is executed with prefabricated box units, and that elsewhere the property in fact raises costs making the company unprofitable in these properties. Another interviewee pointed out that location also affects costs, and stated that their costs are equal to building from concrete in Uusimaa and university cities, but not in smaller cities.

4.1.2 Maintenance costs

All interviewees were asked about their views about the magnitude of maintenance costs in wooden multistory apartment blocks. Maintenance costs do not actually depend on the construction material that much, but more on the choice of surface and facade materials, as was pointed out in the interviews. However, construction material and solutions made in planning do affect the energy efficiency of the house and thus the heating costs. Maintenance costs were included in the questionnaire, since it is important to find all possible factors that can create differences in costs and therefore profitability in WMC.

The problem with evaluating maintenance costs in WMC is that there is not enough actualized cost data from longer time periods. This was also acknowledged and pointed out by the interviewees, who stressed that their comments were only perceptions and not for the most part based on actual comparisons or accumulated data and wished that the topic would be studied to a greater extent.

> *"Our knowledge about this matter is based mainly on rumours, but we should have scientifically valid proof."*

The assumptions of the interviewees regarding the maintenance costs in WMC were positive: none of the respondents saw any reason why maintenance costs in wooden buildings should be higher than those in concrete buildings. Two of the respondents presumed that the costs would be the same as with concrete buildings, whereas the remaining four were uncertain whether the costs were on the same level or even smaller than with concrete. Furthermore, two of the interviewees said, that "at least there has been no surprises" in already built houses, which they found positive. Next paragraphs explain the interviewee's thoughts on different sources of maintenance costs.

Heating costs were mentioned to be the biggest single cost factor in maintenance costs by two of the interviewees. Four of the interviewees argued that heating costs should not differ from those of concrete houses, and two even thought that the energy efficiency of wooden houses could be better than that of concrete houses. One interviewee emphasized that all buildings must fulfil the same energy requirements, and therefore energy efficiency must be at least the same.

Two interviewees mentioned that facades from different materials might create differences in maintenance costs, but also in this case the interviewees did not recognise that any one material would outrank other materials. According to one interviewee, wooden facades require maintenance more often than concrete facades, but they had proved wooden facades cheaper in some destinations when calculating life cycle costs. Another interviewee said that it is unclear which material is the most affordable in the facades and named it "an everlasting debate among researchers". It was also pointed out, that the choice of the material for the facade depends on the cityscape: the facade should look "reasonable" and match the city plan.

One interviewee also mentioned that there have already been water damages in WMC's, and they have been treated without any bigger problems. Another interviewee mentioned sprinkler maintenance as a cost but did not believe it to be significant.

As a conclusion, the problem with maintenance costs of wooden buildings is the lack of data, but all interviewees believed that maintenance costs should be at least on the same level as with other materials, if not even lower. Furthermore, two interviewees mentioned that the maintenance costs do not depend greatly on the material used, but are the result of planning and product development, which should be considered in all types of construction.

> *"I would turn this question about the maintenance costs in WMC so, that controlling maintenance and life cycle costs are a part common project management in all buildings and all construction".*

4.2 Construction time

Construction time was discussed in the interviews, since it is often said to be one of WMC's benefits. Construction time can be divided into time spent in a factory and time spent on-site, i.e. erection time. The division between these two differs between

different techniques and materials, and these differences were also discussed in the interviews. Notably, it was mentioned that using prefabricated box units was faster than building from concrete, but large wooden elements might not have the same advantages. It was especially mentioned that using prefabricated box units does not shorten the overall construction time, but that work is only shifted from the construction site to the factory. In the following paragraphs, construction time means the on-site construction time, if not mentioned otherwise.

4.2.1 Benefits of shorter construction time

The benefits of shorter construction time include smaller financial and labour costs and less disturbance to the environment. One of the interviewees estimated that the savings could be tens of euros per square meter. Three interviewees admitted that shorter construction time would create savings in financial costs, since payments would start to accumulate sooner. The other three did not comment about this, and it felt like this was a topic they had not thought of that much. Two interviewees also answered, that the shorter construction time does not affect their revenues in the current ARA-funded model.

Two interviewees argued that shifting work from on-site to factories significantly reduces costs, since work efficiency is much higher in factories due to standardized work stages and automation. It was mentioned that shorter construction time on-site releases the workers to other sites earlier, which decreases especially overhead and supervision costs. This would mean that the one who benefits most is the contractor, and not so much the client. Additionally, one of the interviewees mentioned that the fastness of wooden construction is beneficial especially in complementary building, since it disturbs the surrounding environment for a shorter time.

4.2.2 Factors affecting construction time

The interviewees estimated that wooden construction is currently 20-30% faster than construction with concrete, and one interviewee even said that the difference is 50%. Even though everyone saw that on-site construction times is shorter with wood, they thought that it was not fully utilized yet, meaning that houses could have been built even faster or that no one really benefitted from the faster erection since this was not

taken into consideration in planning. Reasons for this included poor project management and lack of experience on the constructor's side, which results in too complicated and time-consuming solutions in planning.

> *"All houses are designed from scratch, they are designed individually, there will not be any similar modules, all the building parts, components that are needed are ordered separately and the fastness cannot be utilized since all have their delivery times, and no repetition or familiarization is generated."*

It was also mentioned that the clients have not realized the possibility of shorter construction time and thus cannot take advantage of it. One interviewee compared WMC to concrete construction and argued, that problems in the worksite can be solved quickly when the material is concrete, since people already have experience from similar problems. By contrast, in WMC sites it can take weeks to solve even minor problems, since there are no ready-made solutions. Project management, process planning and supply chain management were mentioned essential in being able to utilize the possibility of faster construction.

Taking into consideration the current inefficiencies and ignorance, it seems logical that all of the interviewees thought that construction time could further decrease in the future. One of the respondents saw it possible that the construction time could be as short as two months, while another one said that five months would be possible but not shorter. A decrease in construction time would, according to the interviewees, require more construction projects and learning from these.

As a conclusion, all of the interviewees thought that building with wood is faster than with concrete, but the fastness has not fully actualised yet due to lack of experience and problems in project management. The respondents were optimistic that the time will shorten in the future.

4.3 Future development

As stated earlier in this chapter, four out of six interviewees said that WMC is currently more expensive than building from concrete, and that the most important reason for this is the small number of completed projects and therefore lack of experience. The third and final research question of this study was "how could the profitability of WMC

be improved in the future?" and the next paragraphs will provide answers to this question.

The interviewees were quite optimistic about the future: all of them believed that in the future the profitability of WMC will improve. Furthermore, they seemed convinced that there would be consumer demand for WMC's. One of the interviewees mentioned, that as long as there is enough demand for WMC, the prices must come down. Another did not believe that the costs would decrease, since "costs always increase, it is a funny feature of them that they never decrease", but maybe also the first comment could be understood more as improved profitability even though costs would have actually increased.

Three of the interviewees also gave their estimates about how the market share of WMC might develop. Two of the interviewees estimated the market share to be 20%, another without a time estimate while the other said that it "would be good if it was reached in the next 10 years". The third interviewee saw it possible that WMC could reach a market share of 30% in the next 10 years, with the assumption that there is enough will to advance it and it is perceived as a good and functional method. Considering the market share is important not only due to the targets set by legislators, but also because the scale of production affects production costs as well, as was pointed out by one of the interviewees. However, according to another interviewee it is normal that the most commonly used technique is the most affordable one, since there are many companies that use it, practises are established and there is competition among companies, which can be a driver to lower costs to gain competitive advantage. From this point of view, higher market share would be beneficial for WMC.

> *"The most common [building technique] is always the most affordable one, and this is because the most common one is the most well-known, it has the most actors and the possibilities for competitive tendering are the best. The most common solution can even be more complicated than the simplest solution, but even so, it is always the most affordable one."*

> *"The biggest thing is, that first an industry needs to be born. We talk about industrial construction, where scale is extremely significant […] as long as there are no attractions, competitiveness will not be any better. What I am maybe trying to say, is that in the future there will be more actors, more attractions, which will decrease unit costs, and this is an inevitable progression."*

Market share is also a particularly interesting question, since concrete is the current market leader and main competitor of wood in construction materials for multistory apartment blocks, and there has been conflicts between the concrete and wood construction industries in the media. One of the interviewees stated, that he does not see it beneficial to create tension between concrete and wood construction industries, since the materials have different properties and are suitable for different projects in different circumstances, and also another one declared that the concrete construction industry has no need to worry.

> *"I don't think that it [wooden construction] will ever override concrete […] concrete construction does not need to worry, they have earlier arranged their position so well that they will have work to do."*

The different properties of different materials were often pointed out in the interviews. The interviewees hoped that construction material would be in the future chosen according to which material fits the attraction best and that different materials would be genuinely competitive. The responses also included criticism towards politicians and decision-makers; instead of city planners or politicians dictating the material in some attraction, the interviewees hoped that wood would be chosen as the material since its qualities fit the attraction best.

> *"Also a constructor's dream would be, that we would have three genuinely competitive materials [wood, concrete and steel], that is the way it should go. There comes a project, you think which material fits here best, and not just try to force wood everywhere."*

> *"I belong to the school of thought that instead of zoning a building lot suited only for wood, we should zone a lot where wood can manage with its own products and the actor can decide the way to execute the attraction. In the beginning, when there are still so few actors, it is good that we get some help from city planning, but in the future we need to get to the point where everyone manages on their own."*

4.4 Ways to increase the profitability of WMC

The positive development that the interviewees believed in will not happen without any effort, and the interviewees listed multiple things that could improve the profitability of WMC. The mentioned means to increase the profitability of WMC were divided to internal and external factors in the analysis of the results and are presented in table 1. Internal factors mean the ways that the companies in the value

chain of WMC can use inside the company, whereas external factors require cooperation with other stakeholders.

Table 1. Ways to increase the profitability of wooden multistory construction discovered in this research.

Internal factors	**External Factors**
Learning • Increase in the productivity of labour • Decrease in construction time	Cooperation with Other Companies • Developing better functioning ways of making tenders
Product Development • Creation of new concepts • Accuracy • High-quality products • Decrease in the prices of materials	Dialogue with Public Administration • Loosening regulation • Harmonizing regulation across different countries • Special construction instructions for wood
Industrial Construction • Automation and prefabrication	

4.4.1 Internal factors

All of the interviewees mentioned learning as a way to improve profitability. The interviewees hoped that getting more experience from an increased number of projects would increase the productivity of labour and decrease construction time, as processes get smoother. It was mentioned earlier that solving problems on site takes a long time in WMC, and according to the interviewees, these problems might also be avoided or at least solved faster due to learning. Furthermore, the interviewees stressed that instead of waiting for someone else to develop the industry further, the companies should start experimenting with simple enough solutions and trust that the know-how will develop in the process.

> *"I see it so, that now that we are in my opinion sort of waiting and waiting for when and how it [wooden construction] will start to boom, that it will come when we get on doing it and learn from it, it will come more competitive all the time, and when we have essentially*

governmental support on this, that really the norms and regulation are loosened to a sensible level for wood, that it will develop favourably."

"We should just have the courage to start doing and making simple solutions, not to aim too high at first and try to take some fancy examples from abroad and say that we need to have this, but start to study WMC. The know-how will come in time, and this way costs will decrease and competition increase."

The second theme that emerged in the interviews was product development. At least two interviewees hoped for breaking off from the traditional way of doing things and creating new concepts specifically designed for wood that would allow large-scale production. Some interviewee stated that the whole industry could transit to a new way of thinking; not copy what has already been done before, but create new solutions and new concepts and thus offer additional value to the customer. As mentioned earlier, planning costs in WMC are high, but according to the respondents, developing products that are pre-designed but could be modified to fit each customer's needs could diminish them.

"In construction we also need these actors, who in a way come and bring a whole new way of thinking and renew it this way. Wooden construction has a very good opportunity here, since many things related to industrial activity are solved automatically in it."

"When we are not building prototypes anymore, but we have this certain WMC system that we can utilize and not always design everything from scratch and have this way thought of cost-efficient solutions, but still solutions that are good enough for the end-user, then we can get to even lower prices than with concrete."H1

Also good quality of products and accuracy in measurements were mentioned as ways to gain competitive advantage and reduce costs from reclamations. Construction companies also hoped that the prices of raw material, especially CLT, would decrease. Furthermore, one of the interviewees stressed that not all responsibility of the industry's development should be put on constructors but wood product manufacturers should also do their share of product development. The interviewee claimed, that the constructors do not want to be developers of new systems, but more the ones who take them to use.

The third theme that arose in the interviews was industrial construction, meaning the automation of different stages of work and prefabrication of construction elements. The interviewees saw that automation would be beneficial in both planning and the

actual construction work. Prefabrication allows using automated work in factories and diminishes time spent on-site, which according to the interviewees decreases labour and overhead costs and also shortens the exposure to weather that might create water damage.

> *"Every building technique has its pros and cons and everyone must find their own way of doing things. I claim, that in wooden construction, improved productivity of work enabled by industrial construction is the solution to these things."*

> *"I want to emphasize that wood enables us industrial construction. I specifically believe in industrial construction, that we can make larger entities in factories [...] in a way wood brings many good things to marketing, brand, image, greenness and such, but the true reason why we use wood is that it allows us an industrially efficient process."*

4.4.2 External factors

Even though it is important that the companies try to internally enhance their operations and aim for more cost effective production, the interviewees also mentioned cooperation with other companies and dialogue with public administration as means to increase the industry's profitability.

The interviewees saw that instead of every company developing only their own processes and products, they should also concentrate more on communication and cooperation with other companies in the value chain. For example, it was mentioned that better functioning ways of making tenders are needed in order to avoid the problems in making contracts mentioned earlier. The interviewees stated, that the growth of WMC and transition towards a more sustainable construction industry would require companies working more together.

> *"When we speak of influence from the society, the biggest point in my opinion is that we should create such conditions, that the whole industry can grow, that separate blocks cannot develop independently, regardless of others."*

The interviewees also stated that the role of public administration should not be underestimated. City planning affects construction companies greatly, and one interviewee wished for an open dialogue with city planners and municipalities to enhance their possibilities for operation. The interviewees wished for looser

regulation, harmonizing the regulation across different countries as well as separate, well-designed construction instructions that consider the characteristics of wood. However, the interviewees gave the impression that loosening regulation was not the biggest obstacle in the way of WMC becoming more profitable. Furthermore, as mentioned earlier in this chapter, they saw quite strongly that materials should not be dictated in plans, but wood should become competitive on its own terms.

> *"I still think, that competitive advantage cannot be based on support from the government or getting cheaper lots or that there are subsidies in taxation […] wood industry cannot trust that competitive advantage always comes with some sort of subsidy, it cannot go like that. Otherwise we are completely wrong somehow, in a market economy."*

As a conclusion, the interviewees had a lot of opinions regarding the profitability of WMC and seemed to genuinely believe in their products and in the market diffusion of WMC. Furthermore, it seemed that they also had some ideological reasons for building with wood instead of operating solely because of promising financial prospects, but this is a topic that would require further studying.

> *"Of course money matters. But it is also nicer to sell and do, when you know that you are also decreasing the carbon footprint, and solutions are often more ecological and sustainable in wooden construction than on concrete's side, but I do not really want to create such confrontation there, we already have enough of that."*

> *"I wish that this is not just a trend of the decade that will come to an end. [I hope we] have good things, good projects, need to hope that we find brave constructors who are willing to carry the risk."*

5 Discussion

5.1 Reflections on previous literature

The results of this thesis were quite similar to those of previous research, but also new aspects were mentioned and some aspects were emphasized more than in previous research. The next chapters compare the results of this study to results of previous research and present the similarities and differences between this and former studies.

5.1.1 Legislation and public support

Previous research has shown that WMC industry stakeholders find the Finnish building codes, especially fire regulation, relatively strict (Hurmekoski et al. 2018) and find that legislation raises the costs of WMC (Riala and Ilola 2014; Hurmekoski et al. 2018), but still stakeholders do not reckon that legislation is the most important barrier to WMC (Hurmekoski et al. 2018; Ijäs 2013, p. 166-168; Toppinen et al. 2018a). The results of this study were similar to those of previous research, since even though the interviewees wished for looser regulation for wood and saw it as a cost-increasing factor, regulation was not considered as the most important barrier for the market diffusion or profitability of WMC. Furthermore, the interviewees wished for open dialogue with municipalities and city planning but did not necessarily see that the state should favour wood by zoning building lots just for wood, but rather make the lots such where wood could be a profitable building material on its own terms. Similarly, in an earlier study by Hurmekoski et al. (2018), WMC professionals feared that changing legislation so that it would favour wood would cause negative publicity, loss of credibility and counter lobbying. In the study by Hurmekoski et al. (2018) the number of interviewees for and against stricter regulation favouring WMC was equal on both sides, but in this study the mainstream opinion was against regulation favouring wood, even though unified regulation across different materials and removing regulatory obstacles was hoped for.

5.1.2 Costs

In general, the costs of WMC have been studied to a minor extent, and therefore this study gives valuable information about the factors that increase the costs of WMC. The majority of the interviewees in this study stated that building multistory apartment blocks is currently more expensive with wood than it is with concrete, and earlier research has showed similar results (Riala and Ilola 2014).

In this research the main reasons given for higher costs in WMC were limited experience, low number of actors, location, planning and problems in tendering. Some of these reasons were also recognized in earlier research, such as the lack of experience, which was identified as a cost-increasing factor by Riala and Ilola (2014). Furthermore, the results of this study indicated that many of the WMC projects completed so far are prototypes or flagship projects, which has raised the costs of WMC compared to conventional construction. Likewise, in a study by Ijäs (2018, p. 180), constructors agreed that the novelty of the industry and the experimental nature of finished projects have led them to perceive that lifecycle costs of WMC are higher than those in conventional construction. However, this study recognized planning as a major reason for higher costs in WMC, and this cost was not mentioned in earlier research.

This study implies that the maintenance costs in WMC are on the same level as in concrete construction, which is conflicting with the study by Ijäs (2013, p. 193). This indicates that something might have changed between these two studies, and at least the constructors have now more knowledge and experience about the maintenance costs in WMC. The respondents also evaluated that the potential lifespan of wooden buildings should be the same as with buildings made from other materials, which is consistent with a survey made by the Athena institute (2004), which showed that degradation of the main structure is rarely the reason for demolishing a building.

Previous research has identified lightness of wood and fastness of construction as factors that decrease the costs of WMC compared to other materials (Tolppanen et al. 2913, p. 176), and also the interviewees in this study regarded that shorter construction time decreases overhead and financial costs and increases work efficiency. Interestingly, none of the respondents gave any comments about lightness of wood,

even though it is often mentioned as a positive feature of WMC, but then again, the interviewees were not specifically asked to comment the lightness of wood.

5.1.3 Barriers

In literature, path dependency of the construction industry is mentioned as one of the most important barriers to WMC (e.g. Nordin et al. 2010) and this path dependency is also visible in the results of this study. However, this research clearly shows that WMC industry experts would be willing to break this path dependency and create a completely new way of doing things, since the interviewees emphasized the need to make things the way that best fits wooden raw material instead of trying to repeat what has been done with concrete.

In earlier research, lack of knowledge and attitudes are also mentioned as important barriers to WMC (e.g. Ijäs 2013, p. 166-168; Määttä et al. 2016; Toppinen et al. 2018a) and the same problems were mentioned in this research. The results of Toppinen et al. (2018a) were in fact very similar to the results of this study, but it should be noted that both studies were made by interviewing WMC professionals in Finland (Toppinen also in Sweden) during roughly the same time, so it is likely that some of the interviewees were the same. For example, Toppinen et al. (2018a) stated, that WMC is still at a very early stage and that the lack of experience and positive examples is a problem for the companies operating in the field, and the results of this study indicated exactly the same views. Furthermore, one of the interviewees in this study also mentioned that the constructors do not want to be developers of new systems, but more the ones who take them to use, and the exact same argument was presented by Toppinen et al. (2018a).

5.1.4 Future

The interviewees of this study were optimistic that the use of wood will increase in the future, which is in line with the findings of Toppinen et al. (2018a). However, achieving the target of tripling the market share of WMC by 2030 does not seem likely based on the results of this study, which was also the conclusion of Hurmekoski et al. (2018), who stated that achieving the target is unlikely and that the construction sector is highly unlikely to actively work towards this goal without any obligation. Increased consumer demand is mentioned as a way to increase the market share of WMC in

literature (e.g. Toppinen et al. 2018b) and also the results of this study indicate that WMC professionals believe that consumer demand will grow.

Interestingly, in a study by Riala and Ilola (2014), interviewees with most experience from WMC were the most critical towards it and mentioned the most negative experiences and problems towards it. According to this study, it seems that the attitudes might have changed, since here all interviewees were experts of WMC yet their attitudes towards it were mostly very positive.

The ways of increasing the profitability found in this study are similar to those found in earlier research. Toppinen et al. (2018a) also divided the factors that could improve the competitiveness of WMC to internal and external, although the division was slightly different, and Riala and Ilola (2014) and Hurmekoski et al. (2018) also mentioned largely the same means as the experts of this study. In particular, Hurmekoski et al. (2018) mentioned alternative ways of contracting as a way to increase competition and also this study indicates that the traditional way of tendering does not function well in WMC. Furthermore, Tolppanen et al. (2013, p. 174-177) argued that WMC can become even faster in the future, and the results of this study imply that the fastness of WMC is not fully utilized yet. Toppinen et al. (2018a) and Nordin et al. (2010) also emphasized the importance of collaboration as a way to enhance the profitability of WMC, and this study came to similar conclusions. Moreover, Parvinen et al. (2009) suggest that value added in the wood products industry should be increased through organizational changes instead of cost reduction, which was also mentioned multiple times in this research.

5.2 Validity and reliability

Validity means the ability of the research method to measure the variable it is intended to measure, whereas reliability refers to the consistency of the results of a study as well as the possibility to reproduce them. It should be noted that these concepts have been developed mainly for quantitative research and may not be directly applicable to qualitative research as such. For instance, interaction between the interviewer and the interviewee always affects the results of the interview, and the results, in turn, are only the researcher's interpretation of the interactive situation (e.g. Hirsjärvi and Hurme 2004, p. 184-190). Thus, the aim of complete objectivity may not be achieved in an

interview study, but this should be accepted as a natural feature of the method. The next paragraphs present the factors affecting the validity and reliability of this study to the extent that they could be analysed.

Possible sources for error in this research arise from the researcher, the interviewees, the interview situation as well as the method of data collection and analysis. Researcher bias was tried to decrease by carefully studying the existing literature about WMC before the interviews and acknowledging the fact that the researcher's background in forestry might make their attitude towards WMC too positive and thus affect the discussion in the interviews and also interpretation of literature and the results. Inductive analysis in qualitative research has indeed been criticised, since the choices and interpretations the researcher makes affect the results (Ruusuvuori et al. 2010, p. 9-29) and the reliability of the study is weakened, if a different researcher could form different results of the same data. The researcher has a great responsibility not only in the rendition of the results, but also in the formation of the conceptual background, since they decide which literature is introduced in the literature review and what is left out. However, objectivity was pursued in all parts of the research project.

When data are collected by interviews, the truth of responses is in a key role for the reliability of the results. The interviewees can intentionally try to make things seem better or worse than they really are or deliberately withhold information, which can skew the results. In this research, the interviewees might have the same kind of interpretation and attitude bias as the researcher, as the interviewees all represent the WMC industry and positive and encouraging results from this research might be useful to them and the companies they represent. Unfortunately, the researcher's means to evaluate the answer's truthfulness were scarce, and mainly the feeling of mutual trust was what directed the interpretation of the responses. Error from the interviewees was also tried to reduce by introducing the researcher and their background as well as the topic and funding of the research openly when interviewees were contacted for the first time and also in the beginning of every interview, where it was also clarified that the answers were anonymous and the thesis would be available for the public.

People behave differently in different social situations, which is why the interview situation and social context might affect the interviewee's answers and create error.

The atmosphere in all of the interviews was good, and it felt like the interviewees could speak freely of their opinions. All of the respondents also had quite a positive attitude towards being interviewed, and they very supportive towards the study and expressed how important it is to study the subject. The interview situations in general were quite similar except for one interview, where the interviewee and the interviewer were not alone but also the interviewer's colleague from Dasos Capital was present. It is possible that her presence would have affected the interviewee's responses, but based on the researcher's judgment of the interview situation, this is determined rather unlikely. After all, the interviewees were all experts on their field, so it is rather unlikely that either the less-experienced researcher or their colleague could have influenced the interviewees' answers.

The choice of the research method is very much linked to validity of the study and was justified in the method section. After the collection and analysis of the data, it could be concluded that the semi-structured theme interviews were suitable to answer the research questions. As also clarified previously, the research questions were in fact modified during the research process, but not because the method itself was deemed unsuitable to answer them but because the selected interviewees could not provide sufficiently comprehensive answers to all predefined themes. Therefore, the problem was more in the choice of the interviewees than in the research method, but as already stated before, it is acceptable that the research questions are defined more precisely during a qualitative research process.

Reliability of the research is also threatened, if the method, data collection and analysis are not documented well enough, which would prevent reconstructing the study. This was tried to avoid by revealing the different phases of the project openly. Furthermore, it is possible that the sample of respondents was too small or somehow biased, but this is also seen unlikely as the results showed saturation and the respondents presented both large and small companies as well as companies that build only with wood and with other materials as well. The validity of the data might have also been threatened in the analysis phase by what Miles and Huberman (1984) call the "holistic fallacy"; the researcher might tend to make data look more patterned, regular or congruent than they are and selectively observe and record certain data at the expense of other data. This might have been avoided by showing the transcribed material to other people as

well and asking if they agreed with the observations of the researcher, but this was unfortunately not possible given the resources of this study.

5.3 Limitations and topics for further research

This study gives valuable indicative results about the perceptions of Finnish WMC professionals of the profitability of WMC and the ways of enhancing it. However, the sample of this study is quite small, which means that the generalizability of the study is weak and that the results should be interpreted as descriptive. Nonetheless, generalizability of the results is often not even the aim of qualitative research to the extent that it is important in quantitative research, so it should not be considered as a major flaw in this study. To gain either more in-depth or more generalizable results, the same topic could be studied in the future with a larger sample and using a different method, for example the Delphi method, survey or structured interviews.

It is also possible that the opinions of one or few interviewees get too much emphasis in this study due to the nature of the semi-structured method used. The aim was naturally to analyse the data as a whole and find similarities in the answers of different interviewees, but since not all topics were discussed in all interviews, it is possible that some interviewees would disagree with something someone else said but could not respond to this since it was not brought up in the interview. However, letting previous interviews affect the topics discussed in the following interviews could be interpreted as steering the interviews to a too large degree, so for the sake of objectivity, it was seen best not to consider previous interviews much when having new ones.

Furthermore, the time between data collection and the publication of this thesis is two years, which is quite long. It is possible that the views of the experts have changed during this time period, but it is assumed that the construction industry develops quite slowly and thus the results of this study are still valid. Also, the interviews were held in Finnish and some meanings might have been lost in the translation of the citations to English. The choice of citations that were included in the study was also done subjectively, which reflects the power of the researcher discussed in chapters 3.1 and 5.2.

Many of the topics that would require more research have already been mentioned earlier in this study. For example, in a study by Riala and Ilola (2014), some

construction industry experts stated that customers are not willing to pay more for environmentally friendly construction, and the consumers' willingness to pay for WMC could be investigated in more depth to gain insight from consumer demand as a driver for WMC. Also consumers' willingness and ability to affect construction material selection could be an interesting topic of research, since consumer demand is mentioned as a way to increase the market share of WMC (e.g. Toppinen et al. 2018b) but research has shown that consumers do not have strong preferences in construction materials (Riala and Ilola 2014) and that developers and contractors have most power to affect material selection (Roos et al. 2010; Hemström et al. 2011).

Quantitative research about the construction time and maintenance costs in WMC could also be beneficial. Research about the maintenance costs of houses built with different materials would help in considering the life cycle costs of construction and ease comparisons between different construction materials, whereas studying construction time's influence on the revenues in WMC and construction in general could be beneficial in attracting new companies to the market. The motives of WMC professionals to work in the industry and to advance it could also be an interesting topic of research, as suggested in chapter 4.4.2.

6 Conclusions

Referring to the first research question of this study, “what are the perceptions of experts of the WMC industry on the current cost level in WMC?”, this study indicates that WMC experts mostly perceive that WMC is currently more expensive than building with concrete even though the opinion does not seem to be completely unanimous within the industry. It is indeed probable that some companies have lower construction costs compared to others, since the costs in WMC depend greatly on the materials and techniques used and those companies that have been operating in the industry for a longer period of time might have benefitted from learning and improved their operation based on previous projects.

This study identified multiple factors that affect the profitability and market share of WMC, which was targeted in the second research question, “which factors affect the profitability and market share of WMC?”. Most importantly, the results of this study suggest that experience and learning are in a major role when considering the aspects that influence the profitability of WMC and that limited experience is the most important single reason for the currently higher costs in WMC. Moreover, this study implies that lack of knowledge, low number of actors, costs caused by planning and difficulties in tendering have affected the profitability of WMC and raised its costs until now.

Consequently, this study identified getting more experience and learning from finished projects as specifically relevant means of improving the profitability of WMC, which are some of this study’s responses to the third research question, “how could the profitability of WMC be improved in the future?”. Other ways of improving the profitability of WMC discovered in this study include product development, utilization of industrial construction, cooperation within the value chain of WMC and open dialogue with public administration.

Political steering concerning construction has increased in the past years, since different authorities have set targets at increasing the share of wood in construction and city planners have set restrictions to construction materials on certain building lots. The results of this study show that WMC industry stakeholders welcome support from the state, but at the same time they wish that the industry could develop and make wood a genuinely competitive material even without restrictions to materials set in city

planning or subsidies to wood. More specifically, the interviewees of this study stated that industrial construction is the best way to make wood a genuinely competitive construction material. The experts interviewed in this study strongly agreed that the profitability of WMC will improve and that the market share of WMC will increase, but the targets set at wooden construction still seem difficult to achieve based on both this research and previous literature, and it remains to be seen how much the use of wood in construction can increase at least in the short term in a situation where construction volume is expected to decrease.

7 References

The Athena Institute. 2004. Minnesota Demolition Survey. Technical report, The Athena Institute.

City of Helsinki, Urban Environment Division. 2008. Honkasuo, asemakaava. ["Honkasuo, city plan"] Retrieved from https://kartta.hel.fi/kaavaselostus/ak11870_selostus.pdf

Confederation of Finnish Construction Industries (RT). 2019. Suhdannekatsaus, huhtikuu 2019 ["Review of the business cycle, April 2019"] [cited 7.9.2019] Retrieved from https://www.rakennusteollisuus.fi/globalassets/suhdanteet-ja-tilastot/suhdannekatsaukset/2019/kevat/rtsuhdannekatsaus_kevat19_net.pdf

Dodoo, A. and Gustavsson, L. 2013. Life cycle primary energy use and carbon footprint of wood-frame conventional and passive houses with biomass-based energy supply. Applied Energy 112 (2013) 834–842.

Dodoo, A., Gustavsson, L. and Sathre, R. 2014. Lifecycle primary energy analysis of low-energy timber building systems for multi-storey residential buildings. Energy and Buildings 81 (2014) 84–97.

European Comission (EC). 2010. Energy Efficient Buildings PPP. Multi-annual Roadmap and Longer Term Strategy. European Commission, Directorate-General for Research, Industrial Technologies, New generation of products. Luxembourg, Belgium.

EC. 2011. Communication from the commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions. Roadmap to a resource efficient Europe, COM/2011/571. Brussels: European Commission

EC. 2012. Strategy for the Sustainable Competitiveness of the Construction Sector and its Enterprises. European Commission. COM/2012/433.

EC. 2014. On Resource Efficiency Opportunities in the Building Sector. European Commission. COM/2014/445.

European Parliament. 2008. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.

Eskola, J. and Suoranta. J. 1998. Johdatus laadulliseen tutkimukseen. ["Introduction to qualitative research"] Gummerrus Kirjapaino Oy. Jyväskylä. 266p.

Finnish Government. 2019. Programme of Prime Minister Antti Rinne's Government 2019, Housing policy. Retrieved from https://valtioneuvosto.fi/en/rinne/government-programme/housing-policy

Forecon. 2017. Presentation at Puupäivä 30.11.2017 by Pekka Pajakkala, senior advisor. Materials available per email.

Forest Sector Technology Platform. 2012. Horizons - Revised vision 2030 for the European forest-based sector. The European Forest-38 based Sector Technology Platform. Retrieved from http://www.cepi.org/system/files/public/documents/publications/forest/2013/FTP_Vision_final_Feb_2013.pdf

Giesekam, J., Barrett, J., Taylor, P. and Owen, A. 2014. The greenhouse gas emissions and mitigation options for materials used in UK construction. Energy and Buildings, 78, 202–214. DOI: 10.1016/J.ENBUILD.2014.04.035

Gustavsson, L., Pingoud, K. and Sathre, R. 2006. Carbon dioxide balance of wood substitution: comparing concrete- and wood-framed buildings. Mitigation and Adaptation Strategies for Global Change. 11: 667–691 C. DOI: 10.1007/s11027-006-7207-1

Gustavsson, L., Joelsson, A. and Sathre, R. 2010. Life cycle primary energy use and carbon emission of an eight-storey wood-framed apartment building. Energy and Buildings 42 (2010) 230–242. DOI: 10.1016/j.enbuild.2009.08.018

Haapio, A. 2013. Puurakentamisen tulevaisuuden näkymät. Haastattelututkimus [”Future trends of wooden construction. Interview study”]. Espoo: VTT Technology 141. Retrieved from http://www.vtt.fi/inf/pdf/technology/2013/T141.pdf

Hansmann, R., Köllner, T. and Scholz, R.W. 2006. Influence of consumers’ socio ecological and economic orientations on preferences for wood products with sustainability labels. Forest Policy and Economics 8, 239–250.

Hemström, K., Mahapatra, K. and Gustavsson, L. 2011. Perceptions, attitudes andinterest of Swedish architects towards the use of wood frames in multi-storey buildings. Resources Conservation and Recycling 55 (11), 1013–1021.

Hemström, K., Gustavsson, L. and Mahapatra, K. 2017. The sociotechnical regime and Swedish contractor perceptions of structural frames. Construction management and economics, 35, 184–195.

Herczeg, M., McKinnon, D., Milios, L., Bakas, I., Klaassens, E., Svatikova, K. and Widerberg, O. 2014. Resource Efficiency in the Building Sector. Final report, Prepared for European Commission by ECORYS and Copenhagen Resource Institute, Rotterdam, the Netherlands.

Hirsjärvi, S., Remes, P. and Sajavaara, P. Tutki ja kirjoita. [“Research and write”] Gummerrus Kirjapaino Oy. Jyväskylä. 436.

Hirsjärvi, S. and Hurme, H. 2008. Tutkimushaastattelu: Teemahaastattelun teoria ja käytäntö. [“Research interview. The theory and practice of focused interview”] Gaudeamus Helsinki University Press Oy Yliopistokustannus. Tallinn. 213 p.

Hoibo, O., Hansen, E. and Nybakk, E. 2015. Building material preferences with a focuson wood in urban housing: durability and environmental impacts. Canadian Journal of Forest Research 45 (11), 1617–1627.

Hurmekoski, E., Pykäläinen, J. and Hetemäki, L. 2018. Long-term targets for green building: Explorative Delphi backcasting study on wood-frame multi-story construction in Finland. Journal of Cleaner Production, 172, 3644–3654. DOI: 10.1016/J.JCLEPRO.2017.08.031

Ijäs, V. 2013. Puukerrostalojen rakentamisen esteet ja mahdollisuudet - Keskeisten suomalaisten rakentamis- ja kiinteistöalan sidosryhmien vertaileva asennemittaus. [”The barriers and opportunities of building wooden multi-story apartment blocks”] Tampere University of Technology. Doctoral Thesis. [cited 26.9.2019] Retrieved from https://tutcris.tut.fi/portal/files/2652042/ijas.pdf

Jones, K., Stegemann, J., Sykes, J. and Winslow, P. 2016. Adoption of unconventional approaches in construction: The case of cross-laminated timber. Construction and Building Materials, 125, 690-702. DOI: 10.1016/j.conbuildmat.2016.08.088

Jungmeier, G., Merl, A., McDarby, F., Gallis, C., Hohenthal, C., Petersen, A.K. and Spanos, K. 2001. End of use and end of life aspects in LCA of wood products - selection of waste management options and LCA integration. Life cycle assessment of forestry and forest products; achievements of COST Action E9 working group 3 ‘End of life: recycling, disposal and energy generation’. Joanneum, Institute of Energy Research, Graz, 4/1-4/25.

Kadefors, A. 1995. Institutions in building projects: implications for flexibility and change. Scandinavian journal of management, 11 (4), 395– 408.

Karjalainen, M. 2002. Suomalainen puukerrostalo puurakentamisen kehittämisen etulinjassa. Department of architecture, University of Oulu.

Korkein hallinto-oikeus (KHO) [”Supreme Administrative Court of Finland”]. 2015. Decisions KHO:2015:56. [cited 16.9.2019] Retrieved from https://www.kho.fi/fi/index/paatoksia/vuosikirjapaatokset/vuosikirjapaatos/1428403349476.html

Mahapatra, K. and Gustavsson, L. 2008. Multi-storey timber buildings: breaking industry path dependency. Building research and innovations, 36 (6), 638–648.

Matinaro, V. and Liu, Y. 2017. Towards increased innovativeness and sustainability through organizational culture: a case study of a Finnish construction business. Journal of cleaner production, 142, 3184–3193.

Maxwell, J. A. 2009. Qualitative Research Design: An Interactive Approach. SAGE Publications.

Metsäkeskus. 2019. Puukerrostalorakentaminen kasvuun Pirkanmaalla. [“Wooden multistory construction to growth in Pirkanmaa”] [cited 30.10.2019] Retrieved from https://www.metsakeskus.fi/puukerrostalorakentaminen-kasvuun-pirkanmaalla

Miles, M.B. and Huberman, A.M. 1984. Qualitative data analysis: A sourcebook of new methods. Beverly Hills CA: Sage.

Ministry of the Environment. 2017. Uusi asetus rakennusten paloturvallisuudesta vähentää tulkintoja ja yhdenmukaistaa turvallisuustasoa. [“A new decree of the fire safety of buildings decreases interpretations and unifies the security level”] [Announcement. [cited 3.6.2019] Retrieved from http://www.ym.fi/fi-FI/Ajankohtaista/Uusi_asetus_rakennusten_paloturvallisuud(45212)

Ministry of the Environment and Puuinfo. 2018. Suomalainen puukerrostalohankekanta. [“Wooden multistory construction projects in Finland”] [cited 28.5.2019] Retrieved from https://www.puuinfo.fi/sites/default/files/Puukerrostalohankekanta%2C%20p%C3%A4ivitetty%2011-2018.pdf

The Ministry of Transport and Communications. 2018. Toimenpideohjelma hiilettömään liikenteeseen 2045; Liikenteen ilmastopolitiikan työryhmän loppuraportti. [“A program for carbon free traffic 2014”] Retrieved from https://api.hankeikkuna.fi/asiakirjat/25f36343-b43d-4a4e-8bd4-83b78fd0188f/ebc53b06-0bf8-474a-9e78-aa59944455a3/RAPORTTI_20181212100813.pdf

Määttä, K., Hietala, J. and Jutila, K. 2016. Puurakentaminen: Sääntelyn kapeikot ja kehittämisvaihtoehdot. [”Wooden construction: limitations in regulation and options for development”] PTT työpapereita 177. 92 s. ISBN 978 952 224 184 9 (PDF), ISSN 1796 4784

The National Building Code of Finland. 2017. Decree of the Ministry of the Environment on fire safety of buildings E1. 848/2017. [cited 3.6.2019] Retrieved from https://www.ym.fi/enUS/Land_use_and_building/Legislation_and_instructions/The_National_Building_Code_of_Finland/Fire_safety

Nordin, F., Öberg, C., Kollberg, B. and Nord, T. 2010. Building a new supply chain position: an exploratory study of companies in the timber housing industry. Construction management and economics, 28 (10), 1071–1083.

O’Connor J., Kozak RA., Gaston C. and Fell D. 2004. Wood use in nonresidential buildings: opportunities and barriers. For Prod J. 54:19–28.

Official Statistics of Finland (OSF). 2017a. Dwellings and housing conditions [e-publication]. ISSN=1798-6761. Helsinki: Statistics Finland [cited 5.9.2019]. Retrieved from http://www.stat.fi/til/asas/2017/asas_2017_2018-05-17_tie_001_en.html

Official Statistics of Finland (OSF). 2017b. Dwellings and housing conditions [e-publication]. ISSN=1798-6761. Overview 2017, 1. Dwelling stock 2017. Helsinki: Statistics of Finland. [cited 5.9.2019]. Retrieved from http://www.stat.fi/til/asas/2017/01/asas_2017_01_2018-10-10_kat_001_en.html

Official Statistics of Finland (OSF). 2019. Building and dwelling production. ISSN=1798-9590. Helsinki: Statistics Finland [cited 7.9.2019]. Retrieved from http://www.stat.fi/til/ras/2019/06/ras_2019_06_2019-08-27_tie_001_en.html

Parvinen, P., Alajoutsijärvi, K., Ollila, I., Häppölä, P., Rosendahl, N. 2009. Suomalaisen puutuoteteollisuuden jalostusarvon kasvattaminen. ["Increasing the Value Added in the Finnish Wood Products Industry"] Consulting study commissioned by TEM, Helsinki, Finland.

Puuinfo. 2018. Puurakentamisen kasvu näkyy tilastoissa. ["The growth of wooden construction is visible in statistics"] [cited 28.5.2019] Retrieved from https://www.puuinfo.fi/tiedote/puurakentamisen-kasvu-n%C3%A4kyy-tilastoissa

Puuinfo. 2019. Valmistuneet puukerrostalot. ["Completed wooden apartment blocks"] [cited 28.5.2019] Retrieved from https://www.puuinfo.fi/articles/valmistuneet-puukerrostalot

Rakennuslehti 18.11.2016. Puukerrostalo tulee betonitaloa kalliimmaksi – tappiotyöt karkottaneet rakentajia. ["A wooden apartment block is more expensive than a concrete apartment block – unprofitable projects have driven constructors away"][cited 6.9.2019]. Retrieved from https://www.rakennuslehti.fi/2016/11/puukerrostaloa-tulee-betonitaloa-kalliimmaksi-tappioiden-pelko-karkottaa-rakentajia/

Riala, M. and Ilola, L. 2014. Multi-storey timber construction and bioeconomy - barriers and opportunities. Scandinavian Journal of Forest Research, 29(4), 367–377. DOI: 10.1080/02827581.2014.926980

Roos, A., Woxblom, L. and McCluskey, D. 2010. The influence of architects and structural engineers on timber in construction – perceptions and roles. Silva Fennica 44 (5), 871–884.

Ruusuvuori, J., Nikander, P. and Hyvärinen, M. 2010. Haastattelun analyysin vaiheet. ["Phases of the analysis of an interview"] Vastapaino, Tampere. 470 p.

Toivonen, S., and Viitanen, K. 2015. Forces of change shaping the future commercial real estate market in the Helsinki Metropolitan Area in Finland. LAND USE POLICY, 42, 471-478. DOI: 10.1016/j.landusepol.2014.09.004

Tolppanen, J., Karjalainen, M., Lahtela, T., Viljakainen, M. 2013. Suomalainen puukerrostalo: rakenteet, suunnittelu ja rakentaminen. ["The Finnish wooden multistory apartment block: structures, planning and construction"] Helsinki: Opetushallitus: Puuinfo

Toppinen, A., Toivonen, R., Valkeapää, A., Rämö, A. 2013. Consumer perceptions on environmental and social responsibility of wood products in the Finnish markets. Scand. J. For. Res. 28 (8), 775–783.

Toppinen, A., Sauru, M., Pätäri, S., Lähtinen, K. and Tuppura, A. 2018a. Internal and external factors of competitiveness shaping the future of wooden multistory construction in Finland and Sweden. Construction Management and Economics, 1–16. DOI: 10.1080/01446193.2018.1513162

Toppinen, A., Röhr, A., Pätäri, S., Lähtinen, K. and Toivonen, R. 2018b. The future of wooden multistory construction in the forest bioeconomy – A Delphi study from Finland and Sweden. Journal of Forest Economics, 31, 3–10. DOI: 10.1016/j.jfe.2017.05.00

Tuomi, J. and Sarajärvi, A. 2009. Laadullinen tutkimus ja sisällönanalyysi. [”Qualitative research and content analysis”] Tammi, Helsinki. 182 p.

Vainio, Terttu. 2016. Asuntotuotantotarve 2015-2040. [“Demand for apartments 2015-2040”] VTT, Espoo. Retrieved from https://www.vtt.fi/inf/pdf/technology/2016/T247.pdf

YLE 25.6.2019. Ilkka: CLT Plantin toimitusjohtaja kumoaa huhut tehtaan ongelmista. [”Ilkka: The CEO of CLT Plant denies rumors about the factory’s problems”] [cited 11.11.2019] Retrieved from https://yle.fi/uutiset/3-10846144

Appendix 1. The Interview Questions

Introducing myself and the thesis and thanking for participating in this research. Asking permission to record the interview.

- Could you introduce yourself quickly: what does your job include and what kind of experience do you have from wooden multistory construction? What is the role of the company you represent in the field of wooden construction?
- What are the best and worst things about WMC?

Costs 25min

- Do you think that it is more expensive to build apartment blocks from wood than from concrete?
    - How much? How do you justify your opinion, have you built them yourself or compared different projects etc.?
- What makes WMC more expensive than building from concrete?
- Could these costs be lowered and how?
    - Has your company done something to lower these costs?
- Are maintenance costs higher in WMC than concrete houses? How much, and what raises these costs?
- How do you think the competitiveness WMC will develop and why? What could and/or should be done to improve it?
- How large do you think that the market share of WMC could be?
- How could the profitability of WMC be improved?

Revenues 15-20min

- Do you think it would be possible to make WMC more efficient in the future? How?
- How much faster do you think it is to build from wood compared to concrete?
    - Do you think that building from wood will become even faster in the future? How much and how
- Do you think it would be possible, that consumers would be willing to pay higher rents for apartments in WMC's?
- Do you think that apartments in WMC's keep their value better than apartments in houses built from concrete or could the value of the apartments rise faster than the value of corresponding apartments in concrete apartment blocks in the same area?
- How long is the life cycle of wooden houses?

Finance 5-10min

- Is it easy to get finance for WMC?
- Is there a need for more finance? What kind of finance should this be?
- Are there differences between the prices of finance between building with wood and with concrete?

Thank you! Would you want me to send the thesis to you when it is ready? To which address should I send it to?